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MANUAL OF

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MANUAL OF

OPERATIVE SURGERY

BY

JOHN FAIRBAIRN BINNIE, A.M., C.M. (Aberdeen); F.A.C.S.

SURGEON TO THE CHRISTIAN CHURCH, THE GERMAN AND THE GENERAL HOSPITALS, KANSAS CITY, MO.; FELLOW OF THE AMERICAN SURGICAL ASSOCIATION; MEMBRE DE SOCIETE INTERNATIONALE DE CHIRURGIE AND OF THE WESTERN SURGICAL ASSOCIATION

SEVENTH EDITION, REVISED AND ENLARGED

WITH 1597 ILLUSTRATIONS
A NUMBER OF WHICH ARE PRINTED IN COLORS

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PREFACE TO SEVENTH EDITION

In this as in all previous editions great care has been taken to avoid the perspective of a text-book where emphasis must be placed on the common rather than on the unusual operations of surgery. The constant endeavor has been to give aid to the surgeon when he is in trouble, hence much greater space has been devoted to some rather rare operations than to many of far greater every-day importance but which ought to be familiar to every one. Thus a chapter has been included on Cardiac Surgery even although, up to the present, such work has been mostly confined to the physiological laboratory. Several chapters have been rewritten, many obsolete illustrations discarded, new figures inserted and a short chapter on Retroperitoneal Neoplasms added. In spite of much new material careful pruning has prevented any great increase in the size of the volume. At the present time of strife it has been thought wise to append a short chapter on War Surgery. This has been made possible through the kindness of Dr. Walter S. Sutton. It is hoped that the earnest effort to keep the work up to date may have been successful.

KANSAS CITY, MISSOURI.

PREFACE TO SIXTH EDITION

The original plan of this "Manual of Operative Surgery" was to devote attention to the advanced operative surgery of the day and to avoid discussion of those topics which were sufficiently described in the text-books on "The Art of Surgery."

Various reasons have compelled the inclusion of subjects such as were originally excluded, but great care has been taken to avoid using the perspective of a text-book where emphasis must be placed on the common rather than on the unusual.

In this work, the constant endeavor is to give aid and guidance to the surgeon when he is in trouble, hence far more space is devoted to such rare and difficult operations as hypophysectomy, than to many operations of much greater every-day importance, but which ought to be familiar to every graduate.

In the present edition, the chapters devoted to operations on the stomach have been largely rewritten, special attention being paid to the anatomy of the gastro-intestinal lymphatics.

Many other chapters have been rewritten and a new chapter has been devoted to the treatment of tumors in general.

It is hoped that the earnest effort to bring the work up to date may have been successful.

J. F. BINNIE.

DEDICATORY LETTER

TWELFTH AND WYANDOTTE STS.,
KANSAS CITY, MO.

DR. ROBERT F. WEIR, New York:

Dear Dr. Weir:—Some considerable time ago you encouraged me in a design to write a little book on operative surgery, in which there should be omitted, as far as possible, all description of those procedures which are ordinarily thoroughly given in the usual text-books on general surgery. You were good enough to look over and express approval of the scheme and of certain sections of manuscript submitted to you. This volume is the outcome of your encouragement, and it gives me intense pleasure to have your permission to dedicate it to you.

Following out the ideas already expressed, I have omitted all reference to such subjects as amputations and ligations. Such portions of genito-urinary and of rectal surgery as are fully treated in the common text-books have been passed over in silence. It was my intention to devote considerable space to the operative surgery of the bones and joints, but having prepared several chapters on these subjects, I found that any adequate treatment of them would require a second volume. The exigencies of space forbidding a satisfactory review of the operations on the bones and joints of the extremities, I prefer to omit such entirely. My aim throughout has been to be practical: to describe operative procedures as they are done on the living subject, instead of on the normal cadaver.

For the bibliography of operative surgery, the reader is referred to the Catalogue of the Surgeon General's Library in Washington.

In the preparation of this volume I have had the benefit of much advice and criticism from our mutual friends, Drs. W. J. and C. H. Mayo of Rochester, Minn. Drs. Block and Mark of this city have kindly revised the chapters on genito-urinary surgery. Drs. E. F. Robinson and R. M. Schauffler gave me much assistance in proof-reading, while my student assistant, Mr. Florian, helped me in many ways. To all these gentlemen and to those who generously placed plates and drawings at my disposal, I beg to return heartfelt thanks.

Hoping that this work of mine may never cause you to regret the encouragement given by you,

I remain,
Your friend,
J. F. BINNIE.

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PART I.—HEAD AND NECK

CHAPTER I

SCALP

REMOVAL OF SEBACEOUS CYSTS (WENS)

Method A.—Make an incision through the skin *into* the cyst. The incision must be nearly as long as the diameter of the tumor. Do *not* squeeze out the contents of the cyst. Seize the divided cyst wall with a strong forceps (hemostat). With a twisting motion it is easy to pull out the whole sac. Apply pressure to the wound for a few seconds. Close the wound with one or more sutures. Dress.

Method B.—Make a free incision through the skin (which is thin over the tumor) down to, but not into the cyst. Dissect out the cyst unbroken. Close the wound. Dress.

Method C.—If the cyst is infected and suppurating, treat it either as an abscess or better excise it plus the infected portion of skin.

In cases where the cyst is not adherent and not inflamed, method A is extremely easy and gives perfect results; opening the cyst permits removal through a comparatively small cut, and the author has never seen harm result from escape of cyst contents.

ANGIOMA OF SCALP

When simple nevi of the scalp require removal by operation, the incision must be made sufficiently far from the disease so that hemostasis may be easily effected; the wound, if extensive, may tax the resources of plastic surgery. Rapidly growing angiomata, those which penetrate the subcutaneous tissues or are large and tumor-like and those which bleed or threaten severe hemorrhage, all call for operation.

Angiomata over the fontanelles often communicate with the longitudinal sinus, hence in these, radical operation should, if possible, give way to less rigorous measures such as ignipuncture. The same is true in the case of cavernous angiomata, which evidently penetrate the skull.

(A) Strangulation.—Pass a stout pin or needle under the middle of the nevus from side to side. Pass a stout thread around the base of the nevus, under the pin (which keeps the thread from slipping). Tie the thread very tightly. Instead of one, two pins may be introduced at right angles to each other. In time the strangulated tissues die, slough off and leave an ulcer. In the twentieth century this treatment savors of barbarism.

(B) Subcutaneous Ligation.—Many methods of subcutaneous ligation have been used; most of them are exceedingly simple.

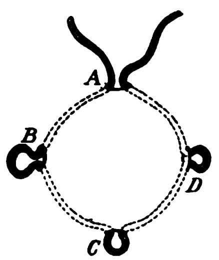


FIG. 1.—Subcutaneous ligation angioma.

I. At the points *A*, *B*, *C*, *D* (Fig. 1) puncture the scalp with a knife. These points must be well away from the disease. With a needle introduce a stout chromicized catgut or a silk suture through *A* and bring it out at *B*, reintroduce at *B* and bring out at *C*; in the same manner carry the suture from *C* to *D* and from *D* to *A*. Both ends of the suture now emerge at *A*. Tie the suture tightly and let its knot retract under the skin through the puncture at *A*. Apply dressings.

II. Krogius ("Centralblatt für Chir.," Sept. 30, 1905) found that compression and ligation even, of the afferent vessels was inefficient in cases of large racemose (cirsoid) angiomata of the scalp; that ignipuncture, injections and excision were dangerous. He therefore

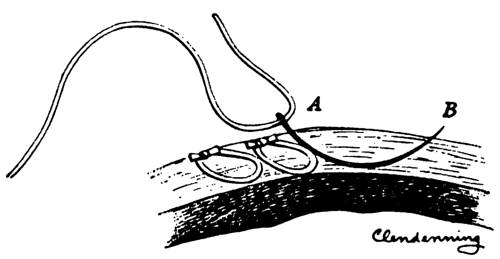


FIG. 2.—Krogius' operation angioma.

devised the following method of subcutaneous ligation: Arm a full curved needle with catgut. Pass the needle from *A* to *B* (Fig. 2), hugging the bone.

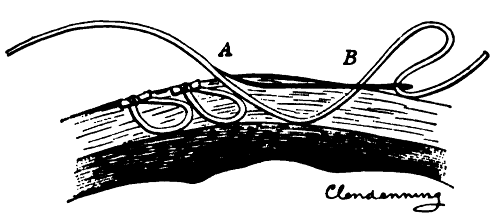


FIG. 3.—Krogius' operation angioma.

Remove the full curved and substitute a less curved needle. With this pass the suture from *B* to *A* immediately under the skin (Fig. 3). Both ends of the suture now emerge at *A*. Tie the suture tightly.

Repeat the process *all round* the nevus until practically every vessel entering or leaving the tumor is controlled. Each suture or ligature should to some extent overlap into the territory controlled by the next one.

(C) **Bryant's Operation.**—Suitable in cases of cirsoid growth. Make an incision outside and nearly round the growth, down to the periosteum. Leave undisturbed that portion of growth containing the largest vessels. Raise the flap and attend to hemostasis. Apply dressings *under* as well as over the flap. When the wound is covered with granulations, replace and suture the flap. If after elevation of the flap for a few days pulsations continue in the flap (the tumor is in the flap), ligate at a distance the main vessel entering it. This method has given J. D. Bryant much satisfaction.

In a case of angioma of the lower frontal region the author operated as follows:

1. Shave the anterior portion of the scalp. Make a transverse incision over the head practically from ear to ear but inside the line of the hair.

Fig. 4.

2. Reflect the skin flap thus formed downwards and forwards until the angioma is almost reached (Fig. 4). At this point, if necessary, cut through the deeper structures until a layer of tissue is found *beneath* the angioma and continue the reflection of the flap downwards in this plane until the lower limits of the angioma are passed. Working from the under side of the flap pass sutures or ligatures around the main vessels entering the angioma from the base of the flap.

3. Treat the flap as in Bryant's operation and a few days later excise the tumor. Replace the flap and close the wound with sutures. The object of this method is of course to avoid making any visible scar.

Clairmont reports from v. Eiselsberg's clinic ("Archiv für klin. chir.," lxxxv, 549) an operation which combined the principles of Bryant's operation and excision. Following Krause, the operation was completed in two sittings. Figs. 5 and 6 show the extent of the disease. A skiagram showed that the middle meningeal arteries were much enlarged. The occipital limits of the tumor were clearly defined; elsewhere it was not well delimited. The use of temporary hemostasis by an elastic band was impossible. Preliminary ligation would have called for the tying of both occipital arteries, the frontal artery (the size of the little finger), and both external carotids near their origin, which might cause danger of embolism. Communicating vessels between the scalp and the inside of the skull were so numerous as to make the gain from preliminary ligations very doubtful. The operation performed may be taken as a guide for the treatment of extremely extensive cirsoid aneurysm of the scalp.

Place the patient almost in a sitting posture. Anesthetize.

Step 1.—Make an incision through the skin and epicranial aponeurosis skirting the growth anteriorly and laterally. Make the cut inch by inch, using compression on each side of the cut against the bone until the vessels are

secured by forceps and ligatures. Isolate and doubly ligate the main vessels before dividing them. This incision outlines a horseshoe-shaped flap having its base at the occiput.

Step 2.—Reflect the flap from the cranium. This step requires the use of many hemostats and ligatures because of the free anastomosis with the deep vessels.

Step 3.—As in Bryant's operation, place gauze between the flap and the bone. Replace the flap over the gauze. Apply dressings and bandage.

Step 4.—After three or four days remove the dressings and excise the tumor from the under surface of the flap. Thrombosis of the vessels in the tumor, and

FIG. 5.

FIG. 6.

FIGS. 5 AND 6.—Cirsoid aneurysm. (*Clairmont.*)

loosening of the surrounding connective tissue due to edema, make the excision of the growth easier than it would have been at the first sitting.

Step 5.—Replace the flap. Suture. Dress the wound.

(D) **Excision.**—It is very easy to excise small nevi and to close the wound with sutures. When large nevi are being excised hemorrhage during the excision may be avoided by tying an elastic constrictor tightly round the head as in trephining or by having a rubber-covered ring (ring pessary) pressed firmly against the scalp surrounding the nevus. The operation consists in excising the disease by cutting through healthy tissue, in securing hemostasis and in closing the wound either directly or by some plastic procedure.

The freezing treatment of nevi threatens to displace all other methods.

Liquid Air.—*First get the liquid air.* Make a very firm pad of cotton on the end of a stick. Dip the pad in liquid air. Shake off any loose drop of the liquid. Press the charged pad with moderate firmness on to the nevus for a few seconds. Repeat the process on every part of the lesion. The treatment is usually painless. Apply no dressings. If any raw surfaces are present on the lesion they must be covered with thin gauze before being treated, otherwise the applicator

would freeze to them (Whitehouse); all scabs must be removed prior to treatment.

The applications may require to be repeated two to three times at intervals of about one week.

Carbon-dioxide Snow.—Instead of liquid air, carbon-dioxide snow may be used and is easily obtained in tanks such as are used in commerce. Permit a spray of the gas to play into a bag of chamois leather. Snow is immediately formed. Put the snow into a cylindrical mould of wood or metal and tamp it down firmly with a stick or pestle. Remove the firm candle of snow from the mould and trim it to the desired shape with a knife. Apply the point of the snow-candle, with moderate firmness for a few seconds, to the part to be treated.

MALIGNANT TUMORS OF THE SCALP

The principles of operation are the same as obtain in other situations, viz. free excision and, especially in the case of epithelioma, removal of the lymphatics which drain the site of disease, when this is possible. The main features of the anatomy of the lymphatics of the scalp are as follows:

(*A*) The lymphatics of the frontal, and the anterior part of the parieto-occipital regions, drain into the parotid lymph glands. These glands for the most part lie in the parotid, and their removal means removal of the parotid. A cancer of the scalp, with secondary nodes in the parotid, is practically inoperable.

(*B*) The lymphatics of the posterior part of the parieto-occipital region drain into the mastoid group of glands lying on the mastoid portion of the sterno-mastoid muscle. These are easily extirpated.

(*C*) The occipital region is drained by two routes. From the outer part, the lymphatics join to form a single trunk which runs downwards to a point under the sterno-mastoid muscle, where it enters one of the external glands of the sterno-mastoid group. From the inner part of the region, the lymphatics go to the occipital glands.

From the foregoing it is clear that only in case of frontal and anterior temporo-parietal cancer, are the lymphatic nodes "next in order" really inaccessible. When a cancer of the scalp is freely movable—excise it thoroughly but leave the skull intact; the wound may be closed by sutures, by flaps of skin, or by skin grafts. When the cancer is adherent to the bone, make an incision down to the bone all round the disease, but in healthy tissue. With the chisel introduced through the incision, cut away all the external table of the skull corresponding to the diseased area. If for any reason it is thought that the disease has penetrated the diploë it becomes necessary to remove the whole thickness of the skull. The cranial defect should be closed at once by the Müller-König method. v. Bergmann writes, "when the disease affects the frontal or occipital regions we do not hesitate to penetrate the dura and remove portions of the cerebral cortex."

CHAPTER II

THE SKULL AND THE BRAIN

EXPOSURE OF THE SKULL

Many means of exposing the skull may be employed, all of which must be preceded by the shaving of a large part, or, still better, of all the scalp. In cases of open fracture, one may expose the bone sufficiently by enlarging the wound already existing. When the operation is for the removal of a foreign body lodged in the bone, a linear incision may be employed. The same incision may suffice to lay bare enough bone for the application of Doyen's perforator or a very small trephine. When a moderate sized trephine is to be used or one desires to explore the surface of the skull, the best incision is one curved in the form of a **U** or horseshoe. Unless specially contraindicated the open end of the **U** should face downwards in the direction of the blood-supply of the scalp. The knife penetrates to the bone at the first cut and the flap is rapidly and readily reflected downwards. Hemostasis must be attended to at once. Before incising

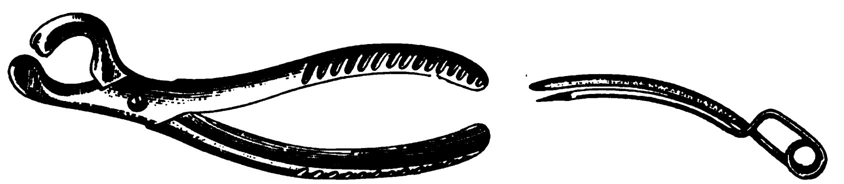


FIG. 7.—Makkas' pin, and forceps for introducing it.

the scalp some surgeons tie an elastic constrictor round the head immediately above the ears so that hemorrhage may be controlled. Lanphear attains the same end by surrounding the site of operation with a continuous chain suture, each stitch of which includes the whole thickness of the scalp. Makkas surrounds the area of operation with clamps, either straight or slightly curved, which assure a bloodless field, Fig. 7. The author has found these very satisfactory. When operating in a region supplied by the temporal artery, it is convenient to have an assistant exert pressure thereon.

When the **U**-shaped incision is preliminary to the reflection of a flap composed of skin, periosteum, and bone, hemostasis must be effected as soon as the cut is made, and the flap outlined must not be separated from the underlying bone.

METHODS OF OPENING THE SKULL

(A) **The Trephine.**—There are two species of trephine, but of these there are many modifications:

1. The ordinary trephine is, in principle, merely a hollow steel cylinder

whose lower end is provided with a saw-edge. To keep the saw-edge in position on the skull, a pin projects through the centre of the cylinder. The pin is withdrawn as soon as the trephine has cut a groove in the bone sufficiently deep to prevent it from slipping. Power is applied to the instrument through a T-shaped handle or a "brace" similar to those used by carpenters. To prevent any sudden onward movement of the instrument into the brain after the inner table of the skull is penetrated, movable guards may be fixed to the outside of the trephine. (See Fig. 8.)

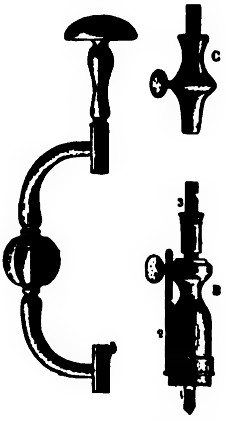


FIG. 8.—Trephine and "brace."

B. Trephine: 1, Center pin; 2, movable guard; 3, stem to fit into brace. C. Extra stem by which burs or drills may be attached to brace. (*Monod and Vanverts.*)

2. ***The Galt Trephine.***—The principle of this trephine is identical with the preceding except that the cutting part of the instrument is shaped like a truncated cone (Fig. 9). The conical shape prevents any sudden onward movement when the inner table of the skull is penetrated. The Galt trephine is most commonly used in America. The only disadvantage of this instrument is that on account of its shape it necessarily makes the button of bone removed much smaller than the hole left in the skull, a matter of some importance if one intends reimplanting the bone removed.

Trephining.—Place the patient with his head resting on a sand-bag and held steady by the hands of an assistant (Fig. 10). Expose the skull as already described. Make the centre pin of the trephine protrude about one-sixteenth of an inch beyond the cutting-edge and bore it into the skull at the selected site. By steady movements of the wrist, twist the trephine from left to right and right to left until it has cut a groove in the skull. Withdraw the centre pin and proceed with the trephining. As soon as the outer table of the skull is penetrated there will be less resistance to the operation and more escape of blood. As soon as hard bone is again met, proceed with increased caution. The inner table is often very thin. After every few movements of the instrument probe the groove in the skull with the blunt end of a straight needle. If probing shows greater penetration at one part of the groove than another, lessen the pressure of the trephine at that point. The inner table is usually found divided at one place before another; when this is the case, by slightly tilting the trephine the place where penetration has already taken place is avoided while the rest of the skull is being divided. As soon as the bone is divided the resulting button is easily removed and the dura mater exposed. Along the edges of the osseous hole there will always be found projecting spicules; these must be cut away with rongeur forceps. If bleeding from the cut bone is severe, it may be stopped by sponge pressure, or, if necessary, by slightly crushing the bone between the jaws of a rongeur forceps. In the author's practice this last procedure

FIG. 9.—Galt trephine. (*Tiemann.*)

has almost never failed to give satisfaction and to have no subsequent ill results. Horsley's wax (beeswax 7, almond oil 1, salicylic acid 1) applied to the bleeding bone is an efficient hemostatic agent. Leonard Freeman finds sterilized chewing gum most convenient for this purpose, but outside of the United States this material will never be within reach. Should there be any intention to

FIG. 10.

FIG. 11.—Use of Keen's forceps.
Appearance of trap-door opening in skull.

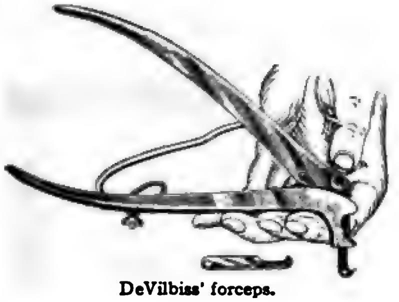
reimplant the button of bone removed, it must, at once, be placed in sterile water and kept at a temperature of about 100° F.

The most convenient size of trephine for ordinary purposes is one three-fourths of an inch in diameter. Smaller instruments are often useful. Trephines having a diameter much greater than one inch are useless owing to the curvature of the cranial vault.

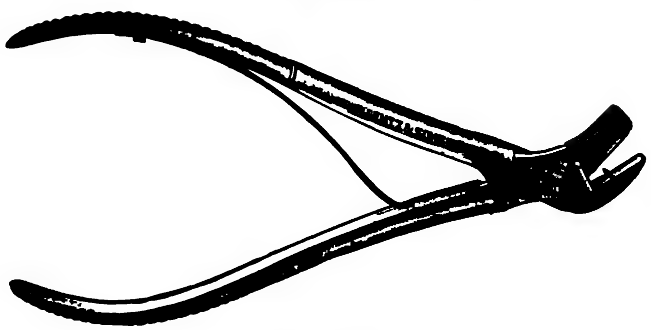
Should it be desired to enlarge the trephine opening, this is easily accomplished by biting away the surrounding bone with rongeur forceps. Keen's forceps are excellent for this purpose (Figs. 11 and 12).

Occasionally the dura is accidentally injured by the trephine and bleeding occurs. When this is the case, enlarge the hole in the skull so that free access is obtained to the dural wound, surround any bleeding vessel by a fine suture, and close the rent in the dura.

(B) Chisel and Mallet.—Especially on the continent of Europe, the skull is frequently opened by means of a chisel. In America and England the method is not a general favorite. The writer has more than once observed severe



DeVilbiss' forceps.



Keen's forceps.
FIG. 12.

shock result from it. Either the ordinary chisel or a gouge with a V-shaped cutting-edge may be employed. Support the patient's head on a sand-bag. Expose the skull as already described. Apply the chisel nearly parallel to the plane of the skull, and by careful use of the mallet make it cut a narrow groove in the bone. The groove is gradually deepened until the inner table is divided. Those skilled in the use of the chisel for this purpose can remove or reflect a large piece of skull in a surprisingly short space of time. The chisel is very useful in operating in cases of fracture, especially of fissured fractures, where it is desired to shave away jagged and injured portions of bone. In the formation of trap-door openings through the skull, the chisel was the original instrument employed.

(C) Gigli Wire Saw.—It is desired to remove a large area of skull in one piece. Expose the skull by a U-shaped incision of appropriate size. At each

of the four corners of the area to be removed perforate the skull with a small trephine or a Doyen's perforator. Doyen's perforator is a very efficient and safe instrument, most conveniently operated by a brace (Fig. 13). Before applying the perforator the outer table of the skull ought to be drilled so as to permit the rounded perforator to bite. With a dural separator, separate the dura from the skull along a line stretching from one trephine opening to another. Introduce an appropriately shaped grooved director to take the place of the dural separator. Pass a Gigli wire saw along the grooved director and leave the director in place to protect the dura. With the wire saw divide the skull from within outwards. Remove the director. Repeat the procedure until the desired area of bone is entirely detached. The Gigli wire saw is an excellent instrument for use in the formation of trap-door openings through the skull.

FIG. 13.—(*Stille.*)

(D) **Forceps.**—After perforating the skull as described in the preceding paragraph, one may divide the bone between the perforations with bone-cutting forceps, *e.g.*, Keen's or DeVilbiss' (Fig. 12), and attain the same result as when the Gigli wire saw is employed.

(E) **Electric Saws, Etc.**—Circular saws and drills driven by the surgical engine are used by some busy hospital surgeons as a means of quickly opening the cranium. They are rarely used in private practice, are useful but expensive luxuries, and any full description of their application would be out of place in a work such as this.

In all the methods of opening the cranial vault which have thus far been described the bone is removed over a greater or less area. Is it necessary to close this defect by anything more than replacement of the reflected scalp? When

the scalp is replaced, in time the bone defect becomes filled with exceedingly hard and strong fibrous tissue sufficient to protect the cerebral contents from injury by ordinary violence. To prevent the formation of adhesions between the scalp and the cerebral contents many surgeons are in the habit of interposing between them divers smooth aseptic materials cut to such a shape that they will fit into the cranial defect. Of these materials, mention may be made of gold-foil, celluloid, thin rubber tissue, the membrane which lies between the shell and white of a hen's egg, etc. If the wound remains aseptic, these foreign bodies will lie in place indefinitely. Their use is particularly indicated after operations for epilepsy, but in the ordinary routine of cerebral surgery the author has distinct doubts as to their value.

Carl Beck's method of using the temporal fascia may be employed (see p. 44).

Macewen fills up the osseous defect with the fragments of bone removed. These he arranges all over the exposed dura like a tesselated pavement. The larger fragments or buttons of bone he breaks into small pieces before implanting them. Excellent results have attended this procedure.

Instead of the fragments of bone removed, decalcified bone chips or particles of bone obtained from other patients or animals have been successfully implanted.

Osteoplastic measures have been devised to close defects in the skull with bone. Müller, König and others have formed flaps consisting of the scalp and the outer table of the skull, and with these have covered the defect.

MÜLLER-KÖNIG OPERATION

***Step* 1.**—Expose the cranial defect (O, Fig. 14) by reflecting the skin-periosteal flap ABC. Excise all scar tissue from the cranial defect and freshen the edges of the bone.

***Step* 2.**—Outline and reflect the flap DFE. In forming this flap cut away with the chisel a portion of the outer table of the skull (G). The portion of bone G is an integral part of the flap DEF, and is of size and shape suitable to be inserted into the cranial defect (O).

***Step* 3.**—Insert the graft G into the defect O, and suture the edges of flap DEF to the bed from which flap ABC was raised.

***Step* 4.**—Implant flap ABC in the bed from which flap DFE was raised.

The operation may be modified by exposing the whole area ACDE by raising a flap of scalp *without* periosteum and then filling the defect O by bone taken from the area H attached to the periosteum and not to the scalp.

Criticism.—During the necessary manipulations, it is difficult to keep the flap of bone from becoming detached from the pericranium. The pericranium normally has little or nothing to do with the nutrition of the bone. The scar in the Müller-König operation is extremely uncouth. While the author has successfully used the method, yet he considers free transplantation of bone far easier, at least as successful and theoretically much preferable.

Röpke ("Zent. für Chir.," No. 35, 1912) has used a part of the scapula in the following manner:

1. After exposing the cranial defect by reflecting a flap of scalp, excise the scar tissue over the brain and vivify the edges of the bone. Temporarily pack the wound with gauze wrung out of hot water. Apply dressings.

2. Place the patient on his right side and pull the left arm forwards. Make an incision about ½ inch to the outer side of the vertebral border of the scapula. exposing the fascia covering the infra-spinatus. Divide the fascia and infra-spinatus just external to the vertebral border but do not divide the periosteum. With a sharp knife dissect outwards, cutting the infra-spinatus from the body of the scapula until an area of the bone is exposed fully as large or larger than the cranial defect.

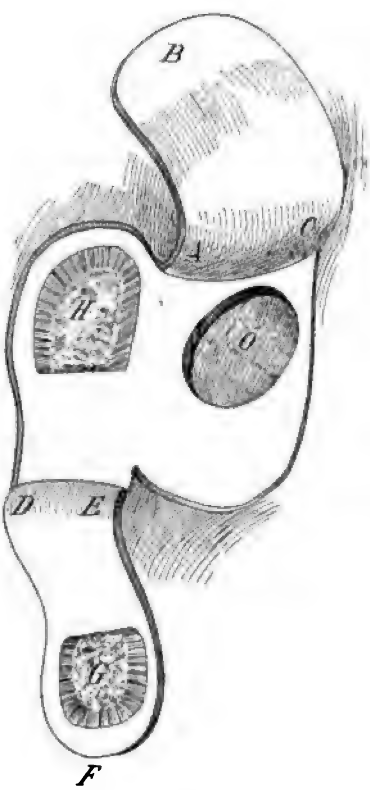


FIG. 14.—Müller-König operation.

With surgical engine, sharp chisel or suitable forceps, *e.g.*, DeVilbiss', divide the bone all round the desired area, being careful to *leave the vertebral border of the bone intact.*

Dissect the isolated plate of bone from the subscapular muscle. Place the fragment of bone in warm salt solution.

3. Attend to hemostasis. Suture the divided infra-spinatus muscle and fascia to the vertebral border of the scapula. Close the wound. Dress.

4. With scissors carefully remove all muscle attached to the bone implant, and place the bone plate in the cranial defect. Replace the scalp. Close the wound. Dress.

Macewen has long recognized the importance of closing cranial defects; most other surgeons were later in doing so, and many to-day are skeptical or disbelieve in its necessity. The later results in cases of skull fractures treated in Körte's clinic support Macewen's ideas forcibly (p. 16). Stieda ("Archiv für klin. Chir.," lxxvii, 532) formulates the following rules:

1. If the wound can be rendered and kept aseptic, close the defect at once by implantation of the fragments removed (Macewen's method).

2. If the wound is healed—do not wait for the appearance of epilepsy but excise the scar tissue from the cranial defect and repair it by the Müller-König osteoplastic method.

Macewen's method is only applicable for closing the skull at the time the skull is opened, *i.e.*, when the bone removed is available for reimplanting.

In the Müller-König operation the fragment of bone transplanted is supposed

to gain its nourishment from the pericranium. In the author's experience, such great gentleness has to be exercised to prevent the fragment of bone from actually falling off the pericranium that it is difficult to imagine any useful amount of nutriment passing from the pericranium to the bone. If this is true, then in view of the success of bone transplantation the complicated Müller-König operation should be discarded and the cranial defect closed by the free (non-pedunculated) transplantation of bone.

This might be accomplished in several ways: v. Eiselsberg did it by using a portion of the tibia covered with periosteum. Undoubtedly the same end could be attained by implanting fragments of the outer table of the skull obtained in the neighborhood of the defect to be filled.

Temporary Osteoplastic Opening of the Skull. Opening of the Skull by Means of a "Trap-door."—This method is of much use when the operation is exploratory or is undertaken for the removal of tumors or of the Gasserian ganglion.

Method I.—Make a U-shaped incision through the scalp around the area to be explored. Attend to hemostasis. With chisel and mallet divide the bone along the line of the skin-incision. It is often recommended that the bone-incision be made obliquely in such a manner that less of the inner table of the skull is removed than of the outer, so that when the flap of bone is replaced there will be no opportunity for it to become depressed. This precaution is entirely unnecessary. The flap outlined by the U-shaped incision of scalp and bone is reflected. To do this it is necessary and easy to fracture the bone transversely at the pedicle of the flap. Very large trap-door openings may be made; especially are such useful when the operation is for the exposure of a tumor.

Method II.—This method is exactly that described in the Hartley-Krause operation, page 70. Figures 54 and 55 show the appearance of a trap-door opening in the skull.

CLOSURE OF THE SCALP WOUND

The scalp wound is closed by sutures. The author always prefers to introduce as few sutures as possible, because there is little tendency to retraction, and in this locality especially, any fluids which may be thrown out in the wound are very much better soaked up in the dressings than retained beneath the scalp. If few stitches are used, drainage is unnecessary even when thorough cleansing of the wound has been impossible, except in the presence of pus, or when a large cavity has been left after removal of tumor, etc. Drainage of the wound by a strip or wick of iodoform gauze has proved extremely unsatisfactory to the author; the gauze has almost always acted as a plug instead of a drain. Of course, where more extensive drainage or packing is indicated, gauze properly introduced acts ideally. In suitable cases drainage-tubes of rubber, glass or decalcified bone (chromicized) are to be employed.

After closing the wound apply the usual dressings. These are most conveniently held in place by a starch bandage.

HEMORRHAGE FROM THE MIDDLE MENINGEAL VESSELS

The middle meningeal artery enters the cranium through the foramen spinosum, usually accompanied by two veins. It divides into an anterior and a posterior branch, which ramify in all directions over the dura. Meningeal hemorrhage is usually accompanied by fracture of the skull, but as it sometimes is caused by violence which does not injure the bone, and even by *contrecoup*, the operative treatment of the latter class of cases must be considered separately.

I. When focal symptoms permit the determination of the site of the bleeding, the indications for treatment are exceedingly simple. Trephine the skull at the site of the hemorrhage. A tough, dark-colored clot will be found. This must be removed with forceps, probe, spoon, and stream of hot water. Probably the trephine opening will require enlargement; possibly, a second opening

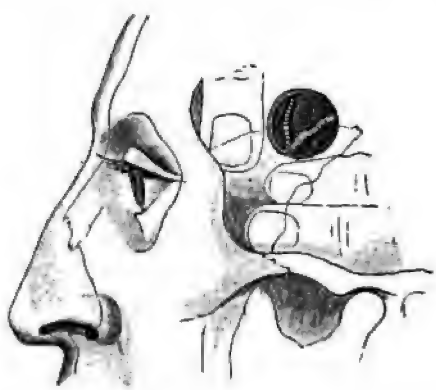


FIG. 15.—Exposure of middle meningeal artery. (*Esmarch and Kowalzig.*)

may be required, as extradural clots are frequently very extensive. If active bleeding continues, search for its source by enlarging the trephine opening with forceps or making another opening as may be required. Ligate the vessel. Examine the dura carefully for signs of injury. If that structure is torn, cleanse the wound from blood-clots and close it with fine sutures. For suturing the author prefers fine silk or celluloid hemp to catgut, merely because the former are so thin that they can be readily threaded on very small needles. If the dura be found distended and discolored, or pulsation is absent showing that subdural hemorrhage is probably present, carefully incise that membrane, remove blood-clot, stop bleeding, and close the dural wound. After the removal of extradural clots the dura soon becomes pushed up against the skull in its normal position, and the external wound may be closed without drainage.

II. In the absence of distinct focal symptoms the trephine must be applied somewhere along the course of the artery so that further bleeding may be stopped and, what is of greater importance, an opportunity may be obtained to explore for and remove the blood-clot. Roswell Park writes: "Vogt and Beck have suggested trephining at a point one and a half inches above the zygoma and the same distance behind the angle of the orbit. An inch trephine at this

point is sure to expose the anterior branch of the middle meningeal artery. Nevertheless, the removal of the clot which causes the compression is much more important than merely finding the artery. Krönlein has made the suggestion of trephining twice, if necessary, in those cases in which the chance of finding the clot is good. He divides these hematomata generally into three classes: (1) fronto-temporal; (2) temporo-parietal; (3) parieto-occipital. He suggests trephining over the artery first, and then, if no hematoma be found and the indications still point to meningeal hemorrhage, to trephine again just below the parietal eminence, because an opening in this position would expose either of the latter classes of blood tumors." (See Cushing's decompressive operation.)

Figures 15 and 16 are self-explanatory.

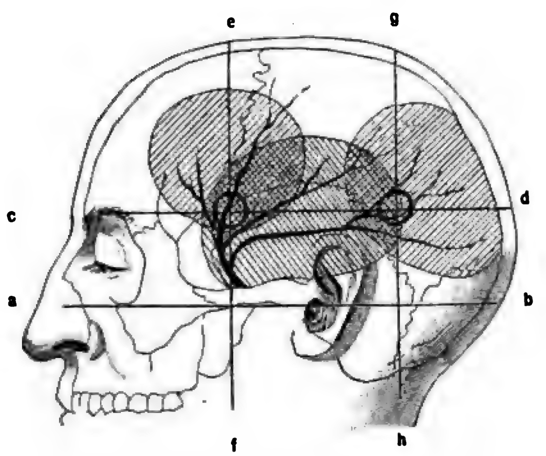


FIG. 16.—Exposure of middle meningeal artery.

a, b. Base line from lower margin orbit through external auditory meatus. c, d. Parallel to a b, from upper margin orbit, backwards. e, f. Perpendicular to a b, and about 1½ inches posterior to external angular process. g, h. Perpendicular to a b, and immediately posterior to mastoid. (*Esmarch and Kowalzig.*)

Steiner has made a careful study of the surgical anatomy of the middle meningeal artery, and as a result has worked out the following method of reaching the vessel.

(A) (1) Draw a line from the middle of the root of the nose to apex of the mastoid process. (2) From the root of the nose draw a line backwards parallel to a line drawn from the lower margin of the orbit through the middle of the external auditory meatus. (3) Bisect the first line by one drawn at right angles to it.

Where the third or vertical line crosses the second (*i.e.*, that parallel to the base line of the skull) is the point to trephine when searching for the anterior branch of the artery.

(B) To reach the posterior branch of the middle meningeal artery, trephine at the point where a line drawn directly backwards from the root of the nose is crossed by a line drawn at right angles to it from the apex of the mastoid process.

OPERATION FOR FRACTURES OF THE CRANIAL VAULT

In cases of compound or open fracture, the wound in the scalp may be enlarged, so as to expose the skull, or, if more convenient, the scalp may be reflected by the usual U-shaped incision, as is done in simple fractures.

1. **Depressed Fracture.**—The principle to be followed is to elevate the depressed bone, remove all dirt, remove all sharp spicules, stop bleeding, and leave everything in the best possible condition for healing.

If beside the depression there is a sufficiently large hole in the skull, the depressed bone may be elevated or removed by means of periosteal elevators, necrosis forceps, or rongeurs. It is imperative, especially in compound fractures, to make an opening in the skull large enough to demonstrate the absence of dirt and hemorrhage. Failure to attend to this may be disastrous; the extra work involved in doing it does no harm. If no opening of sufficient size exists in the skull beside the depression, it is necessary to make one. This is usually done with the trephine. Apply the centre pin of the trephine to the solid skull beside the depression. Part of the cutting-edge of the instrument overlaps the fracture, but most of it lies on the unfractured bone. Remove a button of bone. In operating do not exert any pressure on the fractured fragments of bone lest injury to the cranial contents result. Remove or elevate the depressed bone. Remove blood-clot and foreign material. Stop bleeding. If desired, the fragments of bone may be cleansed and returned if conditions are favorable.* If the dura mater is torn, it must be cleansed and sutured. In severe injuries the brain itself is often much lacerated. The cerebral wound must be cleaned by gentle irrigation with hot water and loose fragments of brain removed. Bleeding must be stopped by ligature, application of hot water, or packing with gauze. The divided dura must be sutured, leaving an opening for drainage or for the gauze packing, and the external wound partially closed. When the dura is destroyed to an extent that its closure becomes impossible, it is wise to cover it with some smooth aseptic material, such as gold-foil, rubber tissue, or the like, unless drainage is necessary. Possibly the implantation of a free mass of fat might be of value (see p. 46). Schulze-Berge has covered the dural defect by splitting the neighboring dura into two layers from the outer of which he formed a flap sufficient to fill the defect. When a drain is required, the part of the brain bereft of dura must be left largely to itself. In one case of the writer's where there was much destruction of brain and dura and the wound was infected the patient recovered perfectly in spite of the appearance of a hernia cerebri. The patient was seen several years after the accident and enjoyed perfect health. Twelve years later epilepsy developed.

* Brewitt ("Archiv für klin. Chir.," lxxix) studied the late results of Körte's cases of complicated fracture of the skull. Of thirty-eight patients treated by reimplantation of the bone twenty-four remained in good health, two had slight and two such severe disturbances that they were unable to work. None were epileptic. Three out of four cases treated by a secondary plastic operation were in good health, one had considerable trouble. Out of thirty cases where the skull was left open only nine remained in good health; two had slight, one severe disturbances; one had epilepsy; eight died from the injury; nine cases could not be traced.

When the fracture is situated over the longitudinal sinus the sinus is liable to be wounded. Bleeding can commonly be controlled by means of packing. Wounds of the sinus have been sutured but its stiff hard walls do not lend themselves easily to direct suture.

Revenstorf ("Centralblatt für Chir.," Sept. 21, 1907) recommends the insertion of a suture such as is sufficiently shown in Fig. 17. The stitch seems as if it would be inefficient but the blood pressure in the sinus is so low that the pressure exerted by the suture suffices.

2. **Fissured Fractures.**—When the fracture consists of a fissure involving *both tables* of the skull, the dangers to be combated are: (*a*) In compound fractures, dirt. (*b*) Intracranial hemorrhage. (*c*) Separation of spicules from the internal table and injury to the brain from them.

These dangers are met as follows: In compound fracture, that portion of the fissure near the scalp wound must be treated on the lines laid down for depressed fracture, and the rest of the fissure treated as if the fracture was of the simple variety. In simple fracture the fissure should be exposed, and with a small trephine, rongeurs, or chisel the skull removed at various points along the line of fissure sufficiently to permit the surgeon to satisfy himself as to the absence of hemorrhage or of the penetration of the brain by spicules of bone.

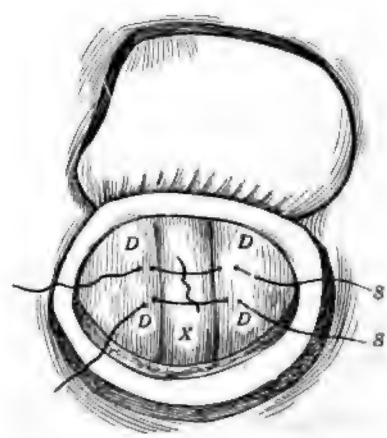


FIG. 17.
X, Longitudinal sinus with rent in it; *S*, *S*, sutures; *D*, *D*, dura.

When the fissure does not involve the inner table of the skull, as demonstrated by probing with the blunt end of the needle it is to be left undisturbed, unless in the neighborhood of a wound of the scalp. When exposed to dirt, as is always the case in compound fractures, the fissure should be cleaned by shaving its edges with a sharp chisel. Fissured fractures are usually met with radiating from other fractures of the cranial vault.

All fractures of the cranial vault ought to be subjected to exploratory operation whether they are depressed or not.

Fractures of the base of the skull when they demand operation do so on account of secondary complications such as hemorrhage and more especially infection. The operation consists in exposure (and if necessary incision) of the meninges low down. The middle fossa is the one most commonly affected and may be reached by Cushing's decompression operation. In an exhaustive paper ("Annals of Surg.," June, 1910) Ransohoff comes to the following conclusions:

"1. There will always be a large mortality connected with basal fractures—death resulting from primary shock, brain laceration or hemorrhage. Thirty-seven per cent. of the fatal cases die within six hours or less, and 56 per cent.

die within twelve hours. It is not probable that the mortality of this class of cases can ever be reduced with or without operation. They are primarily fatal.

"2. Twenty-three per cent. of the fatal cases die during the second twelve hours of the first day and 6 per cent. die during the second day. They are the cases in which the coma is not profound, in which the pupils are not fixed, in which the breathing is not stertorous, and in which there is not complete muscular relaxation. With a slow full pulse and lumbar puncture indicating hemorrhage and increase of intracranial pressure, a trephining operation is indicated. In the doubtful cases, an operation is indicated.

"3. In this class of cases, where facilities for the major operation of trephining are not at hand, repeated lumbar punctures should be essayed. This procedure may be destined to take the place of decompressive operations.

"4. There is a large group of cases in which there is complete consciousness or in which there is a somnolence or milder degree of coma, and in which the concomitant symptoms do not indicate a grave intracranial trauma either to the brain or its vessels. The pupils though uneven, react; involvement of one or more cranial nerves may be evident. The symptoms singly or collectively are not ominous at any time. Eighty per cent. of this class of cases have a tendency to get well with or without operation. They should not be operated on unless the symptoms indicate an increase of intracranial pressure from hemorrhage or beginning cerebral edema, or distinct localizing (cortical) symptoms.

"5. There is a distinct class of cases in which operation is indicated. They are cases which seemingly not severe in the beginning grow progressively or suddenly worse, showing signs of increased intracranial pressure. Decompressive operation may save a considerable proportion of them.

"6. It has yet to be determined where the trephining should be done to obtain the best results. Since most fractures involve the anterior or the middle fossa, subtemporal trephining is doubtless the procedure oftenest indicated. When, however, a hematoma in the mastoid or occipital region indicates an involvement of the posterior fossa, the operation should be subtentorial. To relieve the subtentorial tension by an opening made in the temporal region is illogical and may be dangerous. I attempted it recently in a cerebellar tumor the site of which could not be determined. The patient succumbed within two weeks with symptoms of bulbar paralysis."

REMOVAL OF TUMORS FROM THE BRAIN

Description of the methods of diagnosing and locating tumors of the brain would be out of place in this work. The diagram (Fig. 18) here presented is merely meant to act as a graphic reminder of the generally accepted position of some of the chief centres. Sherrington and Grünbaum find that in monkeys all the motor centres are *anterior* to the fissure of Rolando. F. Krause ("Die deutsche Klinik," viii, 961) has substantiated these findings in man. Fig. 19 represents, on the left hemisphere, the results of Krause's investigations in twelve operations. J. C. DaCosta and others agree with Sherrington's views.

It is necessary, however, to study the relations which the sulci and convolutions of the brain bear to certain landmarks on the skull, so that it may be possible to expose the brain at the desired spot.

The simplest and most easily remembered means of finding the fissure of Rolando is that devised by Bennet (Fig. 20). At right angles to the sagittal suture draw two parallel lines, the anterior of which (*c–d*) runs along the anterior margin of the external auditory meatus; the posterior (*e–f*) touches the posterior

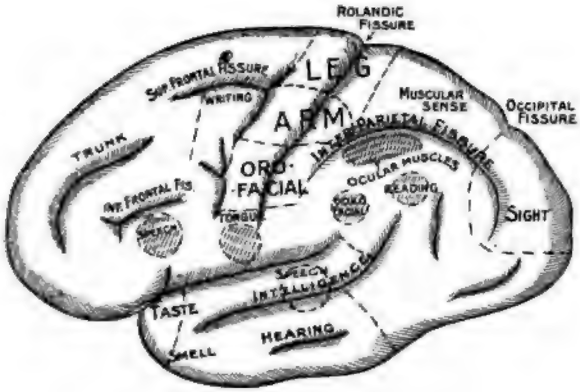


FIG. 18.

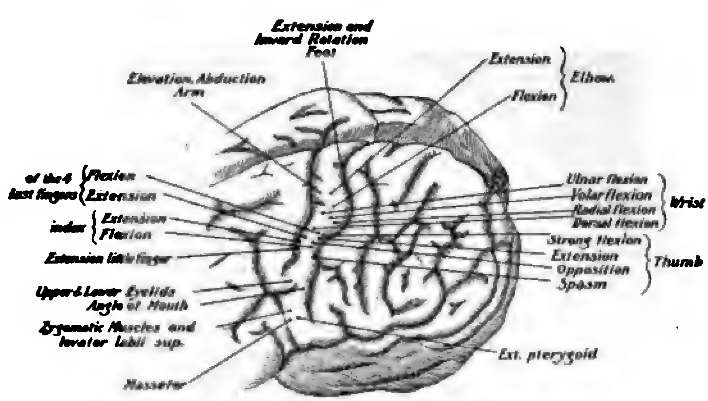


FIG. 19.

margin of the mastoid process. These two lines will be about two inches apart. On the anterior line take a point (*g*) two inches above the external auditory meatus, and from it draw a line (*g–e*) upwards and backwards to the point where the posterior line meets the sagittal suture. This oblique line is about three and three-quarter inches in length and corresponds to the Rolandic fissure.

The simplest means to find the point of bifurcation of the Sylvian fissure is the following (Esmarch): Draw a line one and one-half inches above and parallel to the zygoma. Draw a vertical line three-quarters of an inch posterior to the frontal process of the malar. These two lines cross at a point correspond-

ing to the bifurcation of the Sylvian fissure. Vogt's method of finding the same spot is more easily remembered. The desired position is two finger-breadths above the zygoma and one thumb's width behind the frontal process of the malar (Fig. 15).

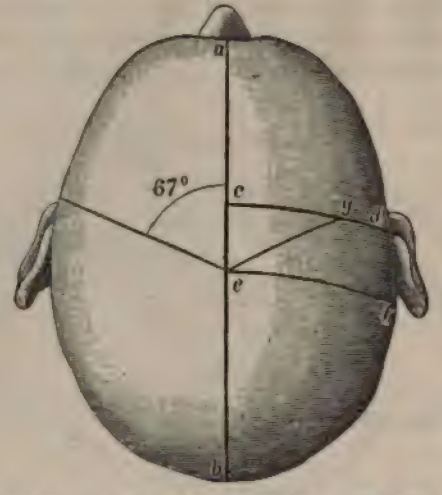


FIG. 20.—Bennet's method shown on the right; Thane's* on the left. (*Esmarch and Kowalzig.*)

FIG. 21.

A more elaborate system for finding the cortical centres is that of Chiene ("Sajous' Annual," 1895) (Fig. 21): "Shave the head and find, in the median line of the skull, between the glabella (G) and the external occipital protuber-

* *Thane's Method.*—Draw the line *a–b* (Fig. 20) from the root of the nose to the external occipital protuberance. Take the point *e*, three-fourths of an inch posterior to the middle point of *a–b*. A line drawn forwards and outwards from *e*, at an angle of 67 degrees to *a–b*, corresponds to the fissure of Rolando.

ance (O), the following points: The mid-point (M), the three-fourths point (T), and the seven-eighths point (S). Find also the external angular process (E) and the root of the zygoma (P) immediately above and in front of the external auditory meatus. Having found these five points, join EP, PS, and ET. Bisect EP and PS at N and R; also bisect AB at C and draw CD parallel to AM. The pentagon (ACBRPN) corresponds to the temporo-sphenoidal lobe, with the exception of its apex, which is a little in front of N. MDCA corresponds

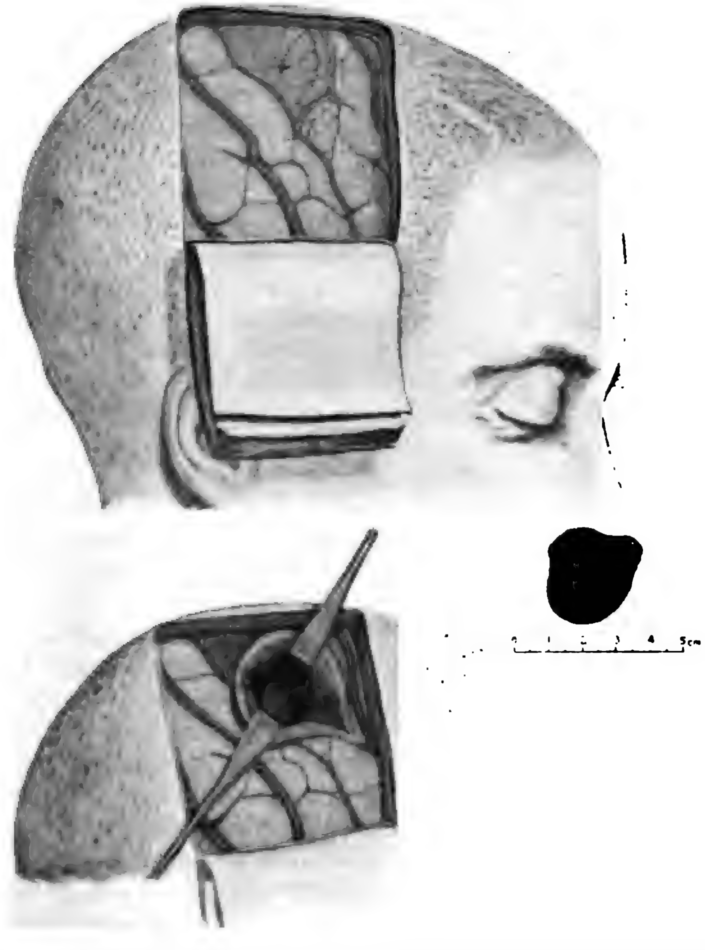


Fig. 22.—Osteoplastic exposure of cerebral tumor. (*Krause, Die Deutsche Klinik.*)

to the Rolandic area containing the fissure of Rolando, the ascending frontal and the ascending parietal convolutions. A is over the anterior branch of the middle meningeal artery and the bifurcation of the Sylvian fissure; AC follows its horizontal limb. The lateral sinus at its highest point touches the line PS at R. MA corresponds to the precentral sulcus, and, if it be trisected at K and L, these points will correspond to the origins of the superior and inferior

frontal sulci. The supramarginal convolution lies in the triangle HBC. The angular gyrus is at B."

Having determined by measurement, etc., the point at which removal of bone will expose the tumor, mark that point on the scalp with iodine, nitrate of silver, the point of a cautery, or, what is far better, puncture the scalp with a small drill which at the same time marks the outer table of the skull. If it seems proper, any desired areas of the skull may be mapped out by a series of drill marks.

Step 1.—Reflect the scalp and open the skull as already described. Generally one of the osteoplastic or trap-door openings is best. If the patient is weak or if there has been much loss of blood and shock sustained during this step of the operation, attend to hemostasis, apply dressings, and defer further in proceedings for a few days. If the tumor cannot be removed, the mere opening of the skull often relieves distressing symptoms, *e.g.*, agonizing headache.

Step 2.—Examine the exposed cranial contents both by inspection and palpation. In cases of tumor and blood-clot it is usual to notice an absence of cerebral pulsation and the dura often bulges into the trephine opening. By palpation tumors have been correctly located at a depth of one inch from the surface. Fig. 22 shows the appearance of a subcortical gliosarcoma in the arm centre, before and after incision of the meninges. Having recognized and determined the superficial boundaries of the growth, reflect the dura mater as a U-shaped flap. If the dura is involved in the growth, part of it must be sacrificed. When encapsulated, the tumor itself is removed by careful dissection with blunt instruments; a plain silver teaspoon is very useful for this purpose. Infiltrating tumors are unsuited for operation. Hemorrhage is arrested by gentle ligation of vessels when this is possible; by the application of gauze pads wrung out of hot water and by packing with iodoform gauze. The cavity left in the brain may require drainage by means of gauze, but the brain soon expands and fills up the space. After the active operation is completed, close the wound in the dura and scalp, leaving, of course, an opening for the emergence of the gauze. If the skull has been opened by the trap-door method, enough bone must be removed from the flap to permit of proper drainage. When a portion of the dura mater has been excised, it is well to protect the brain by the application of a layer of rubber tissue or celluloid. This measure is only feasible if drainage is not required. If the tumor is cystic, drainage of the cyst is often recommended as sufficient, but in the author's experience this has proved futile, and he has been compelled to operate again and remove the cyst-walls.

Hemorrhage and shock are not the only dangers to be feared in cranial operations. It is well known that when the ventricles have been opened a dangerous condition of hyperpyrexia may develop. (Bergmann, de Verco, Parry Davenport: quoted by A. Broca, "Precis de Chirurgie Cerébrale," p. 323.) Sir Victor Horsley is of the opinion that a thermo-taxic centre exists in the cortex and that when this centre is injured a condition of hyperpyrexia prevails independently of any injury to the ventricles. One case seen by the author, ni which the skull was opened with chisel and mallet but the dura was undis-

turbed, died in a state of marked hyperpyrexia before sufficient time had elapsed for septic changes to have developed. Another case reported to the author by H. E. Pearse supports Horsley's contention. This case was one of depressed fracture. At the operation a rubber drainage-tube was inserted. Immediately the temperature rose to a high degree. The dressings were removed and the drain was found to have slipped between the skull and brain. On removal of the drain the temperature returned to normal and the patient made an uninterrupted recovery.

DECOMPRESSIVE OPERATIONS ON CRANIUM

Macewen, Horsley and others have found much good follow exploratory opening of the cranium in cases where tumor was present but could not be removed. The opening in the skull permits the tumor to grow without exercising so much pressure on the cranial contents. Under such circumstances the non-elastic dura is capable of keeping up injurious pressure, hence when decompression is desired the dura should be incised or a portion of it be excised.

Operations of the class referred to are known as "decompressive operations."

Whenever feasible, tumors of the brain should be removed, but frequently it is impossible to find the location of the tumor or to remove the tumor if its precise situation is known. Under the above circumstances a decompressive operation at the site of election is indicated not as treatment of the tumor but as treatment of the distressing symptoms, vomiting, headache, choked disc, etc.

If the tumor is believed to be in the cerebrum, Harvey Cushing has shown that it is advantageous to open the skull under the temporal muscle. In this situation the bone is thin and non-vascular, while the temporal muscle and fascia, if properly preserved, form an efficient covering for the brain and prevent an undue hernial protrusion in case there is a great increase of intracranial tension. If the tumor is below the tentorium cerebelli the skull may be opened through the occipital bone.

***Method A*.—Cushing's Subtemporal Decompression Operation.**

***Step* 1.**—Make a curved incision about ½ inch within the line of origin of the temporal muscle at the temporal ridge (Fig. 23). This cut should be entirely within the hairy scalp. Cut through the skin and subcutaneous tissue alone. Reflect the skin flap downwards. Do not injure the temporal fascia. An additional flap may then be made of the aponeurotic layer.

***Step* 2.**—Split the temporal fascia in the direction of its fibres where these run downwards and forwards. (If the fascia is split where its fibres run vertically less room is obtained.) Carefully retract the edges of the wound in the fascia.

***Step* 3.**—Split the temporal muscle between bundles of its fibres. Do not cut any muscular fibres transversely. Divide the periosteum corresponding to the wound in the muscle. Separate the periosteum from the bone in front of and behind the wound. Retract the edges of the wound so as to expose the bone as thoroughly as possible (Fig. 24).

***Step* 4.**—Penetrate the skull, preferably with a Doyen bur. With rongeur

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forceps remove as much of the skull as possible from under the elevated soft parts. Before attacking any portion of the bone be sure to separate the underlying dura from it. Bleeding from the bone may be controlled by Horsley's wax. An opening 2½ to 3 inches in diameter is easily made and is usually sufficient.

Step 5.—Open the dura and incise it radially to the margins of the defect in the bone. The anterior incisions should be made parallel to the posterior branch of the meningeal artery which may need ligation.

FIG. 23.—Photograph of patient four days after a decompressive operation by the temporal route. (*Harvey Cushing.*)
To show line of incision. He had previously been bedridden. Complete alleviation of symptoms.

Step 6.—Close the muscle wound with a few fine interrupted sutures. Carefully close the wound in the temporal fascia with fine sutures each of which takes as small a bite of tissue as is possible. Accurate approximation is most important. Close the aponeurotic layer and finally the skin wound.

Cushing makes use also of the above method for explorations of the temporal lobe for abscess, etc., for cases of meningeal (extradural) hemorrhage, for drainage in cases of fracture of the base of the skull. Under such circumstances both sides of the skull may be opened and the removal of bone need not be so extensive.

Method B.—**Cushing's Decompressive Operation Over the Cerebellum.** (See Cushing, "Surg., Gyn. and Obstetrics," Oct., 1905, and Spiller and

zier, "Journ. Amer. Med. Assoc.," Sept., 1906.)—It is doubtful whether this thod has any advantage over the subtemporal method as a decompressive asure in cerebellar tumors. The difficulties and dangers of the operation considerable. Hemorrhage from the bone and dura, and especially from the ns leading into the mid-occipital sinus, may be hard to overcome.

Step 1.—Make a curved incision (Fig. 25) a little above the superior curved e of the occiput. Make a longitudinal median incision running downwards m the middle of the curved incision (Fig. 25). Reflect downwards and out-rds the two triangular flaps of skin thus outlined until the upper portion or

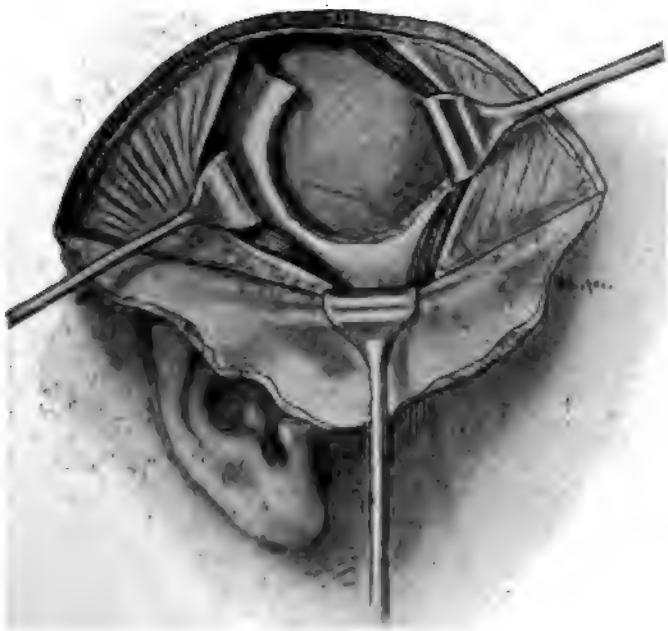


Fig. 24.—Sketch of the intermusculo-temporal field of operation. (*Harvey Cushing.*)
Showing exposure with bone defect partially made.

rigin of the flat superficial cervical muscles is exposed. Divide the muscles rallel to and about ¾ inch from their line of origin. Make a median vertical cision between the muscles down to the spines of the upper cervical vertebræ nd divide the *ligamentum nuchæ* in the middle line. Retract the soft parts. xpose the base of the occiput by separating the periosteum from it and with he periosteum separate the attachments of the deep muscles.

Step 2.—Open the skull on each side through the prominent thin bosses of he occiput. Enlarge the openings with rongeur forceps. The ridge of bone in the middle line must be attacked with great care because of the occasional mid-occipital sinus and emissary veins. Cushing finds it helpful "to crowd wisps f sterile cotton ahead of the dural separator when freeing the membranes

from this mid-ridge, a procedure which necessarily ruptures and blocks these emissary vessels in case they are present."

Step 3.—When the bone defect is large enough, ligate the median occipital sinus and excise the dura corresponding to the opening in the bone.

Step 4.—Close the wound preferably without drainage. On account of

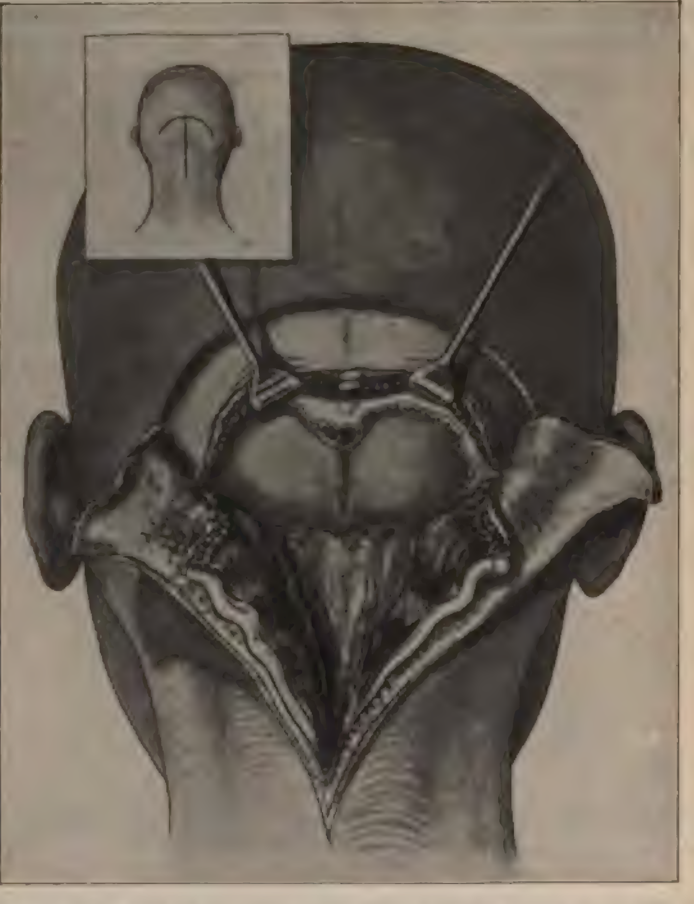


FIG. 25.—Sketch of the field of operation, before opening the dura, in the suboccipital procedure. (*Harvey Cushing.*)
Note the high transverse cut of the "crossbow" incision.

oozing of blood a drain of folded rubber tissue or of oil silk may be employed, but it should be withdrawn within forty-eight hours.

Anton suggested that in cases of inoperable or unlocalized brain lesions (tumors, internal hydrocephalus, etc.) intracranial pressure might be lowered by perforating the corpus callosum, whereby a free communication would be established between the ventricles and the subdural space. If the intraventricular pressure is above normal the fluid must flow out into the subdural

space and in doing so keep the perforation patent. Experiments made by Rehn show that such a flow does take place. The anterior and middle thirds of the corpus callosum form the best site for puncture as it is thinnest here and one or other of the lateral ventricles is sure to be penetrated. A careful study of callosal puncture has been made by v. Bramann ("Archiv für klin. Chir.," xc, 689), who operates in the following manner:

1. Choose a spot about one finger-breadth behind the bregma (1 to 1½ cm. behind the coronary suture) and expose the skull here by any suitable incision.

2. With a bur (Doyen's, Sudeck's) make an opening 1 cm. by 1½ to 2 cm. through the skull at right angles to the sagittal suture.

3. Note the longitudinal sinus and at its margin make a small opening through the dura mater.

4. Pass a sinus forceps (v. Bramann uses a special pliable silver cannula with a mandrin) alongside the sinus into the longitudinal fissure where it meets the falx. Guided by the falx, pass the instrument vertically downwards until it penetrates the corpus callosum.

5. Open the blades of the forceps (or remove the mandrin from the cannula) and permit the ventricular fluid to escape. Enlarge the callosal opening by moving the instrument gently backwards and forwards (not laterally).

6. Remove the instrument and close the wound in the scalp.

v. Bramann has performed callosal puncture in twenty-two patients without a death attributed to the operation (cerebral tumors thirteen; hydrocephalus eight; epilepsy one).

Anton and v. Bramann believe callosal puncture indicated: 1. In all cases of hydrocephalus where internal treatment has failed.

2. In all cases of tumors and pseudo tumors of the brain accompanied by internal hydrocephalus and choked disc which threatens blindness.

3. When intracranial pressure is so great as to interfere with palpation of the brain or with the removal of tumors, preliminary callosal puncture may aid.

OPERATIONS FOR INFECTIVE DISEASE OF THE MIDDLE EAR AND CRANIAL CONTENTS

Cerebral abscess is almost always the result of chronic otitis media. Proper treatment of the cerebral abscess requires removal of the original focus of disease. In the following pages the author makes free use of Macewen's classical work on the "Pyogenic Infective Diseases of the Brain and Spinal Cord." The reader is advised to carefully study the above book before attempting any operation for cerebral abscess. The present chapter is only written in the hope of aiding some practitioner who is forced to operate without the advantage of such study.

Suppurative disease of the middle ear unrelieved by treatment administered through the external meatus is always complicated by disease of the mastoid. The chief indications demanding operation on the mastoid cells are:

1. Repeated inflammations of the mastoid antrum and cells with swelling over or fistulæ leading into the bone.

2. Acute inflammation with retention of pus in the antrum or cells.

3. The occurrence of initial symptoms of intracranial involvement associated with chronic purulent otorrhœa.

4. Persistent chronic otorrhœa, not principally due to the condition of the tympanum or Eustachian tube, and which is considered by the aurist otherwise incurable, even although there are no clear indications of mastoid involvement.

5. If the discharge contain virulent organisms, if it be highly offensive, mixed with osseous débris or cholesteatomatous masses, operation is indicated, as most serious intracranial mischief is often present without marked mastoid swelling.

FIG. 26.—C, F, E (X). Suprameatal or Macewen's triangle.
A. B. Upper two-thirds of this line overlies the sigmoid sinus. C, D. Overlies sigmoid sinus from knee to commencement.

The Operation.—I. Cleanse the external and middle ear as thoroughly as possible. Shave the scalp above and behind the mastoid. Cleanse the skin.

Step 1.—Place the patient on his side with the affected mastoid uppermost. Have the parts well lighted. Pull forward the external ear. Palpate the mastoid and the posterior root of the zygoma. Make a perpendicular cut about one-quarter inch behind the posterior border of the external bony meatus from the posterior root of the zygoma to a point about one-third of an inch from the tip of the mastoid. The knife penetrates to the bone. With the elevator separate the periosteum and soft structures from the bone in front of the cut and thus fully expose the posterior aspect of the external auditory meatus. Attend to hemostasis. Hold the reflected tissues and auricle forward with a sharp retractor.

Step 2.—Observe the limits of the suprameatal triangle, viz., the posterior root of the zygoma above, the upper and posterior segment of the bony external

meatus below, and an imaginary vertical line (EF, Fig. 26), extending from the most posterior portion of the external osseous meatus to the zygomatic root, behind. This vertical imaginary line is the base of the triangle. Observe the degree of obliquity of the posterior wall of the external auditory meatus as it leads inwards and forwards to the middle ear. By the aid of a probe observe the depth of the inner wall of the tympanic cavity from the level of the skull.

The best instrument for use in penetrating the bone is a bur rapidly rotated by a surgical engine. One may conveniently use a bur operated by the "brace" shown in Fig. 13. Apply the bur to the bone at a point inside and beside the base of the suprameatal triangle. Penetrate the outer shell of hard bone. In some cases the whole mastoid is thickened and sclerosed by disease. With the bur, slowly and cautiously advance through the bone in a direction inwards and a little forwards, parallel to the posterior wall of the external auditory meatus. Do *not* use the bur as if it were a drill, making a uniform cylindrical perforation the same size as the instrument; this would be dangerous and nearly useless. Use it to make a hole in the mastoid very much larger than the instrument—large enough to permit of the continuance of the work under the guidance of the eye as well as of touch. The external opening may safely be made the whole size of the suprameatal triangle. Whenever a dark spot is seen on the cut surface of bone, examine it at once with a fine probe or searcher (a dental probe is good). The dark spot is probably an opening into one of the mastoid cells or even the antrum; if the latter, the probe will find a large cavity communicating with the middle ear. The depth of the antrum from the surface varies from ⅛ to ¾ inch. A small opening having been made in the antrum and its cavity explored with a probe, bur away all its external wall, remove all pus, granulation tissue, or other disease products.

II. Observe the position of the opening between the antrum and the middle ear, the position of the facial nerve traversing the inner half of the floor of the antral passage obliquely from without inwards, as it passes into the inner wall and roof of the tympanum above the foramen ovale. The nerve route is often indicated by a cylindrical ridge of bone smoother and denser than that in the neighborhood. If the position of the nerve is not positively made out, have an assistant observe the patient's face for the occurrence of twitchings if the nerve is endangered in the subsequent proceedings. In observing the condition of the tissues deep down in the wound light should be thrown in, either by means of a head mirror or of an electric lamp (with reflector) held by an *aid*. Examine the roof of the antrum for evidences of bone disease. If buds of granulation tissue sprout from the roof, examine them; they may come from inside the skull and show the presence and location of intracranial involvement.

Step 3.—Examine the mastoid cells opened during exposure of the antrum; if they are diseased, as evidenced by the presence of granulation tissue, pus, etc., destroy their walls with the bur, so that instead of numerous, irregular, small cells, one large cavity with smooth walls is formed. Remember the location of the sigmoid groove and sinus (Figs. 26 and 28). Because of the sinus it is wise to open the mastoid cells by working from the antrum downwards and back-

wards. Never attack an exposed cell before thoroughly exploring it with a probe. Remember that granulation tissue and other disease products may be continuous from the middle ear through the antrum, mastoid cells, sigmoid groove, and sinus to the cerebellum. If granulations are found sprouting out from the sigmoid groove or other evidences show disease in that locality, do not yet attack it. Complete the thorough cleansing of the antrum and mastoid, bur away all partitions, and leave them as one cavity with smooth walls.

Step 4.—The middle ear is diseased and requires to be opened. Apply a small bur at the junction of its roof with the outer wall of the antral passage. Do *not* touch the floor or inner wall of the passage for fear of injury to the facial nerve or semicircular canal. Freely expose the tympanic attic and examine its roof in the same way as the roof of the antrum was examined. Examine the malleus and incus; if diseased, remove them. It is important to leave the stapes, if possible; but if diseased, it also must be removed. If the mastoid, antrum, and middle ear are the only seats of disease, the active operation is ended; the cavity is packed with iodoform and boracic acid (1:4) and with iodoform gauze. Closure of the wound is facilitated by removal of a portion of the posterior bony wall of the external auditory meatus. Dressings are applied.

Step 5.—If on examination of the roof of the antrum or tympanic cavity erosions of the bone exist and granulations sprout out from the cranial cavity, or if there are symptoms of intracranial involvement, active operation is continued. With the bur remove the eroded bone of the antral or tympanic roof in a direction outwards from the perforation. If pus and granulation tissue present, there is an extradural focus which must be carefully cleansed. Do *not* inject any fluids until the whole space between the dura and bone has been explored and the presence or absence of openings through the dura made certain. If there is no dural opening, gentle washing is safe, and the extradural space may be dressed with iodoform and boracic acid and iodoform gauze. If there is evidence of disease under the dura, clean the extradural space and freely open the dura.

Step 6.—Pus in the arachnoid or pia or on the surface of the brain must be gently washed away, and iodoform and boracic acid powder must be applied. If an abscess exists in the temporo-sphenoidal lobe, enlarge the opening through the roof of the antrum and tympanic cavity, apply iodoform and boracic acid to the wound, and proceed to Step 7.

Step. 7.—Extend the cut through the soft parts upwards and expose the skull above the ear. Open the skull with a small trephine whose centre pin is applied at a point three-fourths of an inch above the posterior root of the zygoma and in line with the posterior osseous wall of the external auditory meatus. Rub iodoform into the cut surface of the bone. Incise the dura. If necessary, make a crucial incision. Stop bleeding. If the abscess is large, the brain will probably bulge and fail to pulsate; if smaller, neither of these signs may be present. To explore for pus use a trocar and cannula or a sinus forceps. A hollow needle is liable to become plugged. Introduce the instrument inwards, downwards, and slightly forwards, so as to impinge, if pushed far enough, against

the cranial aspect of the roof of the tympanum. If a trocar and cannula are used, the trocar should be removed at every quarter inch of progress to see if pus escapes; if a sinus forceps, the blades should be slightly opened for the same purpose. After pus is found, remember that the abscess probably contains sloughs and shreds of tissue too large to escape through the cannula and which must be removed. Alongside the cannula introduce closed, narrow-bladed hemostatic or sinus forceps; open the blades gently and permit the sloughs to flow out between the blades. If the sloughs cannot escape by themselves, they may be assisted out by forceps or spoon; their removal is of prime importance. After removal of the sloughs replace the hemostatic forceps by a small cannula. Through the mastoid wound and the opening through the antral roof introduce into the abscess cavity a cannula at least one-half as large again as that already *in situ*. Be sure that the end of this tube is in the cavity. It is wise to let the two cannulæ come in contact. Gently introduce a stream of hot water or mild antiseptic solution through the smaller tube and see that it all escapes through the larger. Lest fluid should enter the Eustachian tube, fill the middle ear with the iodoform and boracic powder. In an acute abscess which has been thoroughly cleansed of infective matter, a drainage-tube is of little value and may do harm. If there is doubt as to the thoroughness of the evacuation, introduce a decalcified bone drain so that its opening is just within the abscess. Stitch the drain to the skin. If the abscess cannot be properly drained, in the above manner, use a rubber or glass tube for from twenty-four to forty-eight hours. Treat the mastoid opening as already described (page 30). Close the temporal opening with or without drainage on ordinary surgical principles.

[If abscess of the temporo-sphenoidal lobe exist, without indication of disease requiring the mastoid to be opened, the operation is carried out practically as described in Step 7; but in washing out the abscess an escape for the fluid must be provided by means of a cannula, at least half as large again as that through which it enters. The two cannulæ lie side by side.]

Step 8.—It has already (Step 3) been shown that disease of the sigmoid groove may be discovered while the mastoid cells are being obliterated. Examination with the fine probe or searcher shows that buds of granulation tissue coming through osseous openings are continuous with the same tissue in the sigmoid groove. Apply the bur to the posterior wall of the antrum and with it remove the bone horizontally backwards for half an inch. In a majority of cases this will open the greater part of the diameter of the sigmoid groove sinus, after which it may be opened above and below that point as may be indicated. The anterior knee of the sinus is situated from one-eighth to a quarter of an inch behind the base line of the suprameatal triangle (Fig. 26). If it seems necessary to open the sigmoid sinus to remove septic blood-clot, fully one inch of the sinus ought to be exposed, vertically, by removal of bone. Remove any diseased tissue lying between the groove and the sinus. If, on examination by the eye and the probe, the disease is found to extend through the bone into the cerebellum, this disease route must be followed and cleansed and any cerebellar abscess attended to in the manner to be described. If there is septic sinus

thrombosis, open the sinus and remove the filth within it. After cleansing the sinus, introduce into it a quantity of iodoform and boracic acid powder, make the walls of the sinus collapse, gently pack the sigmoid groove with the same powder, and loosely pack the whole cavity with iodoform gauze. If during the operation hemorrhage take place from a non-thrombosed sinus, it may be stopped, if slight, by temporary pressure; if more severe, by separating the wall of the sinus from the bone and pushing the loosened wall inwards by means of iodoform gauze packing. In certain cases Horsley has found it valuable to doubly ligate and divide the internal jugular vein. This is intended to prevent dissemination of the infective material throughout the body.

Step 9.—In the preceding step it has been shown how extension of disease through the sigmoid sinus to the cerebellum may be discovered. If this is the case, the disease is followed and the bone between the sigmoid groove (outer aspect of the groove) and the cerebellum is removed by the bur. The membranes covering the cerebellum are treated in the same manner as were those covering the temporo-sphenoidal lobe. If a cerebellar abscess exist, enlargement of the osseous opening already made permits of its evacuation and treatment on the principles already described.

After-treatment.—If there is no evidence of petrous or internal ear disease, the wounds must be packed with iodoform gauze to compel healing to take place from the bottom. The whole cavity ultimately becomes a solid mass of scar tissue. In the presence of petrous or internal ear disease a seton of iodoform gauze must be passed from the middle ear, through the antrum out by the mastoid opening. This gauze seton is frequently renewed and its route kept clean, until epithelium from the mucous membrane and the skin has so covered the track that a permanent fistula is assured through which any discharge from the internal ear or petrous bone may escape. The formation of the permanent sinus may be hastened by lining it with skin grafts.

After the dressings are applied put the patient to bed, and keep him there until the wounds are completely healed. A low liquid diet is recommended for a fortnight after cerebral abscesses have been evacuated. The only peculiarity of the after-treatment is the necessity of a little extra insistence on quiet, and on the observance of the usual rules adopted after major surgical operations.

Abscesses in other localities of the brain, after being diagnosed and located, are operated upon on the same principles as have been described in the preceding pages.

OPENING THE MASTOID WITH THE CHISEL AND RONGEURS

Undoubtedly the bur operated by a surgical engine is the most elegant instrument with which to open the mastoid antrum, and it possesses many advantages over the chisel; but comparatively few surgeons possess the necessary instruments nor are they convenient to carry to a patient's home when the patient cannot or will not enter a hospital. Most surgeons possess some dexterity in the use of the chisel but are not educated to the bur, hence the chisel and its

relative, the rongeur forceps, are the instruments commonly used in the mastoid operation.

The operation often ends immediately after the mastoid antrum is opened. This is improper, as the antrum is only one of many mastoid spaces, any or all of which may be diseased.

Whiting ("The Modern Mastoid Operation"), in his superbly illustrated book, shows how the "air-cells" may extend above and over the bony meatus, and unless these are obliterated, the suppurative process is sure to continue. The principle of the complete operation on the mastoid is the obliteration of *all* the mastoid cells and the removal of all disease wherever situated, as described in the preceding pages. The method of operating usually adopted by the author is much as follows:

Clean the ear as well as possible. Shave and clean the skin over and around the mastoid.

Step 1.—Make an incision parallel to the insertion of the auricle and about 1/4 inch posterior to the external auditory meatus. The incision stretches from just above the root of the zygoma to a little below the tip of the mastoid. Expose the whole surface of the mastoid by reflecting the soft parts along with the periosteum. A second incision at right angles to the first may be necessary to insure exposure. Examine the bone for points of necrosis or for the escape of pus at the vascular orifices.

It is especially important to examine the mastoid vein at its outlet, which is usually near the posterior margin of the bone. The vein varies in size and may divide into several branches as it passes through the skull. As the vein communicates directly with the sigmoid sinus, when the latter is thrombosed the former is likely to be in the same state. Thrombosis of the mastoid vein is positive evidence of sinus thrombosis; apparent patency of the vein is of no significance. Pus oozing from the mastoid foramen signifies pus situated outside the dura in the cerebellar fossa, about the sigmoid groove.

Step 2.—Pull the external ear well forwards with a retractor. Observe the depth and direction of the external auditory canal. Beginning at the upper part of the suprameatal triangle, shave off *thin* slices of bone downwards and forwards towards the tip of the mastoid, always hugging the posterior margin of the bony meatus. This shaving is to be done with a chisel or gouge about 1/4 inch in width, propelled by a mallet. The chisel must be held almost parallel to the surface of the bone, and must always be directed downwards and forwards.

The usual chisels and gouges supplied for mastoid work are short and have thin shanks and handles. Such may be safe and convenient in the hands of aurists, but to the general surgeon a chisel with a handle like a Macewen osteotome, or even a carpenter's tool, is much safer and more practical. It is well to have a number of chisels or gouges of different sizes.

After several exceedingly thin slices of bone have been removed, the diploë will be reached, unless there is much sclerosis.

With a narrow curette scrape away the superficial portion of the diploë. If pus or fluid appears, note its quantity, as this gives some index to the size of the

cavity from which it comes; note also if the pus is thrown out in jets or pulsating fashion, because such pulsation is communicated from the brain and is almost absolute proof that the disease has penetrated at least to the meninges. With a probe gently explore the pus-cavity and enlarge the opening with curette, gouge, or rongeur, as may be convenient. *Never* endeavor to clean out a pus-cavity in the mastoid with the curette through a narrow external opening—it is too dangerous. If no pus or fluid appears, deepen the groove already cut in the bone to the extent of ⅛ inch. If the sigmoid sinus is abnormally far forwards, it ought now to be visible as "a soft, bluish-looking structure, very fluctuant to palpation and perhaps pulsating demonstrably, which upon gentle pressure of a probe yields readily but does not bleed" (Whiting). When the sinus is found in this abnormal position, the rest of the operation consists in exposing all the diseased cavities and evacuating all infective material, without injuring the sinus, unless that structure is involved in the process. When the sinus is not abnormally placed, proceed with the removal of all the outer wall of the mastoid process.

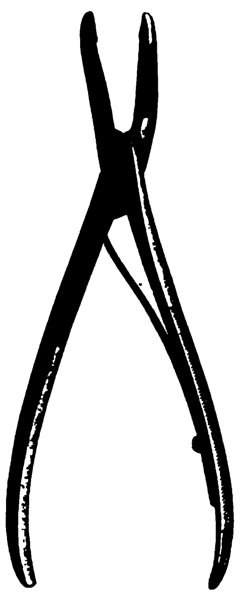


Fig. 27.—Narrow-bladed rongeur forceps.

Step 3.—With the chisel repeat the manœuvres by which the mastoid was originally opened, and so widen the existing opening that the blade of a rongeur (Fig. 27) can easily enter it and pass under the bone. With a rongeur carefully bite away the whole bony outer wall of the mastoid process. Never attack any part of the bone before making sure that the sigmoid sinus will not be injured.

Instead of widening the original opening in the bone with the chisel, the author usually inserts into it, partially, one blade of a heavy rongeur, the other blade of which rests against the mastoid farther back. By exerting a twisting force it is easy to use the posterior blade of the forceps as a fulcrum, and with the anterior blade (the blade engaged in the bony opening) to scrape off a thin layer of the cortical bone. This method of using the rongeur is difficult to describe, easy and safe to practise, and aids materially in the operation. When the mastoid has once been opened to such an extent that the rongeur can be used efficiently, either as a biting or as a scraping instrument, put the chisel and mallet aside as of no further use. If much sclerosis is present, this rule does not apply.

Step 4.—No attempt has been made, as yet, to find the antrum or systematically to obliterate the mastoid cells; the cortical bone has been removed, at least to a large extent; the diploë has been but little disturbed. Remember that the antrum in 99 per cent. of cases (Macewen) lies in whole or in part within the suprameatal triangle; that in the adult its depth beneath the cortical bone varies from one-eighth to three-fourths of an inch.

With a probe, once more observe the direction and depth of the bony meatus.

With the curette, cautiously remove the cancellous bone from the suprameatal triangle in a direction parallel to the posterior wall of the bony meatus. This will almost inevitably open the antrum. If the bone is much sclerosed, a small gouge must be used instead of the curette. Having opened the antrum, explore it thoroughly with a probe. With the curette, aided, if necessary, by rongeur forceps, remove all the external wall of the antrum. In the same manner remove *all* the mastoid air-spaces. Every step in the removal of bone must be preceded by careful examination of the tissues to be removed; remember particularly the normal site of the facial nerve (Fig. 28) and the normal, and particularly the abnormal, course of the sigmoid sinus.

FIG. 28.—Left temporal bone.

Antrum and most of the mastoid cells obliterated. 1. Semicircular canals. 2. Location of facial nerve in aqueduct of Fallopius, which has been opened. 3. Location of signoid sinus.

The mastoid has now been converted into a comparatively shallow pit. Examine the walls of the pit carefully to see whether the disease process does or does not penetrate the cranial cavity. If the disease involves the sigmoid sinus or the meninges elsewhere, it must be attacked according to the principles already enunciated.

In *acute* mastoiditis, after the antrum, etc., have been cleaned out, the inflammation of the tympanum will promptly recede; hence it is unnecessary to use the curette in the tympanic cavity (Whiting). This is fortunate, as otherwise much damage to hearing might easily be inflicted. In cases of chronic mastoiditis and otitis the tympanum must be thoroughly opened and appropriately treated along the lines laid down on page 29 *et seq*.

Step 5.—With rongeur forceps and curette make smooth the floor and sides of the bony defect. Partially close the wound in the soft parts with sutures.

Pack the remainder of the wound with iodoform gauze. It is comforting to the patient to have the gauze separated from the wound by a layer of perforated oiled silk or rubber tissue. After granulations have formed along the course of the pack they may be covered by Thiersch's skin-grafts. This is usually two or three weeks after the operation.

It must be remembered that in children under three years of age the mastoid process is either absent or its presence is merely indicated, while the antrum is to be sought rather higher than in the adult. In these young children the bone is so soft that the antrum may be opened with a curette.

In cases of acute (not chronic) mastoiditis Stenger makes a short incision over the mastoid, reflects the periosteum and, if no fistula is present, chisels or bores a narrow passage towards the antrum. He curettes this passage (which need not penetrate the antrum) or the fistula, if such is present, and loosely packs with gauze, dries the surrounding skin and applies a cupping glass provided with some form of pump for suction. A sterile ointment spread on the skin makes the cupping glass act better. The suction is kept up not longer than three hours at a time. The suction causes pain while it acts, but the relief is great during the intervals. Stenger and Hasslauer report excellent results and a shortening of convalescence. ("Muenchner med. Wochensch.," Aug. 21, 1906.)

The use of suction by means of the cup undoubtedly may help drainage, but its main object is to obtain hyperemia and the whole procedure is based on the ideas of Bier.

OPERATIVE TREATMENT OF MENINGOCELE AND ENCEPHALOCELE

Operation should not be undertaken in cases of the above tumors when there are serious concomitant malformations or when it is believed that portions of brain, necessary to life, are present in the growth. Horsley has suggested the application of the induced current to the tumor in order to diagnose if important cerebral tissue is involved. Some surgeons—*e.g.*, Berger—believe, and act on the belief, that any cerebral material present in a meningocele is neoplastic in nature and possesses no physiological function and may safely be disregarded. With the exceptions mentioned above, Chipault considers all cases of meningocele suitable for operation. [Meningoceles of the cranial vault are alone referred to at present.]

The Operation.—Trace out two flaps of skin alone, over the tumor. The base of each flap corresponds to the pedicle of the tumor. Reflect the flaps. Expose the pedicle of the tumor at its exit from the skull. Transfix the pedicle, with a blunt needle, close to the skull, in one or more places, and apply two or more interlocked catgut ligatures. Tie the ligatures. Cut away the tumor distal to the ligatures. Replace the skin-flaps. Suture. Dress. Instead of ligating the pedicle as above described, it is better to open and explore the sac. If brain tissue is present, looks normal in character, and is reducible without giving rise to symptoms of compression, reduce such brain tissue, excise the

rest of the tumor, and close the opening in the cerebral membranes with suture. If no brain tissue is present, excise the sac. If brain tissue is present but is either abnormal in appearance or irreducible, it must be excised. From the literature of nine years Chipault collected fifty cases of meningocele subjected to operation with only nine deaths.

Meningoceles protruding through the base of the skull are rarely in situations accessible to the surgeon. In one case Fenger gained access to the tumor by temporarily resecting the superior maxilla, and saved his patient. When it is possible to expose a basal meningocele the principles of operation are the same as those already described.

MICROCEPHALUS. IDIOCY

Lane, Fuller, and Lannelongue advised removal of portions of the skull in cases of microcephalus, on the supposition that the early closure of the skull and consequent defective bone cavity impeded cerebral development. Variously shaped portions or strips of skull have been removed by many surgeons and the primary results seemed promising. The author in several cases was astounded to find, even on the day following operation, marked improvement in the condition of such patients. The improvements in speech and mentality were truly incredible, but in not one of the cases observed by him were these improvements retained, and he is forced to conclude that such operations are worthless. They will not be described here.

HYDROCEPHALUS

The earliest attempts to treat hydrocephalus by surgical means consisted in the application of strapping to the head in the endeavor to prevent its increase in size or to diminish its size. Such means were doomed to failure. Later, paracentesis was resorted to, and cerebrospinal fluid was removed in greater or less quantity, but though repeated paracentesis occasionally gave relief yet sooner or later meningitis generally developed and death ensued.

Mikulicz suggested draining the cerebrospinal fluid into the tissues under the scalp and this procedure was carried out in several different ways. Metal tubes were inserted so as to conduct fluids from the ventricles to the subcutaneous tissues. Silk threads, formalinized arteries or veins were used for the same purpose but, as is noted elsewhere, while temporary success was not infrequent, the subcutaneous tissues refused to continue acting as absorbents and permanent good results were notable because of their absence.

Leonard Hill (quoted by Cheyne and Burghard) has shown that the amount of cerebrospinal fluid is regulated by absorption and exudation from the veins or lymphatics of the brain, more especially towards the base; and if any cause interferes with the normal regulation of this cerebrospinal fluid the result on the brain will be very serious. Meningitis interferes with this regulation, so that the fluid collects in the ventricles and causes hydrocephalus. The meningitis at fault is specially present at the base of the brain near the fourth ventricle,

obstructing the exit of fluid from the ventricles, and hence its proper absorption. Based on the above, G. A. Sutherland and one of the authors referred to, attempted to establish the natural absorption by the following operation:

Reflect a flap of scalp and open the skull near and posterior to the anterior fontanelle (occasionally the lower angle of the fontanelle itself has been opened). Incise the dura. Take about twelve strands of thin catgut 2 to 3 inches in length and tie the ends together. Pass one end of this bunch of catgut downwards and backwards between the brain and the dura until about 3/4 inch is left projecting from the opening in the dura. Seize the free end of this projecting portion in a forceps and push it through the brain into the lateral ventricle. Thus a catgut drain is made to stretch from the ventricle into the subdural space. Close the wound in the dura and the scalp. As a rule, the temperature runs up to 104° or 105°F., but falls again in the course of a week or ten days. The skull soon diminishes in size to a very marked degree.

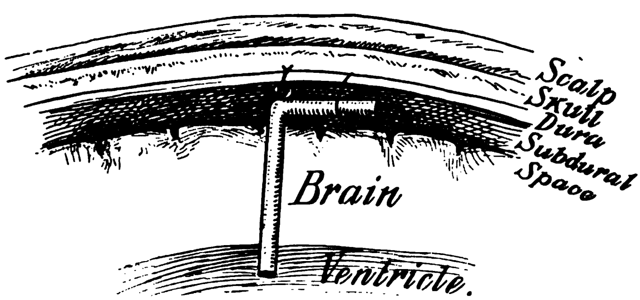


FIG. 29.—Ballance's method of ventricular drainage.

The results have been better in congenital than in acquired hydrocephalus; in the latter it has been extremely difficult to keep up a channel of communication between the ventricles and the subdural space, and it has been suggested to use a more resistant form of drain. In spite of the success attained, the patients have generally succumbed, after a few months, to progressive. meningitis.

Ballance ("Am. Surg. Assoc.," 1906) finds the thread drainage insufficient, therefore he uses a fine Γ-shaped tube of pure platinum or of gold and iridium (pure gold is too soft). One limb of the tube is provided with a small ring or loop near the angle. One leg of the tube is made to penetrate the ventricle, the other leg lies between the brain and the dura, being fixed to the latter by sutures (Fig. 29).

Ballance has had a number of complete recoveries from hydrocephalus following ligation of both common carotid arteries at an interval of about ten days. In these cases there is no special danger from shutting off both common carotids.

v. Bramann endeavors to attain the same end by means of puncture of the corpus callosum (see p. 26).

The blood pressure in the cerebral sinuses being very low Payr conceived

the idea that it would be possible to drain cerebrospinal fluid directly into the longitudinal sinus. As an aqueduct from the lateral ventricle to the sinus a tube lined with endothelium and provided with valves to prevent reflux of blood is desirable. Such a vein as the great saphenous, if transplanted, is calculated to fulfill the requirements.

Payr's Operation ("Archiv für klin. Chir.," lxxxvii, Hft. 4).

1. **Make** a transverse U-shaped flap consisting of skin periosteum and bone as shown in Fig. 30. The convexity of the flap is on the side to be drained and its pedicle, 2 to 3 cm. wide, is at least one finger's breadth to the opposite side of the mid-line. Reflect the flap.

2. On each side of the longitudinal sinus elevate a U-shaped flap of dura having its base towards the sinus.

3. With an exploring needle of small size and having a scale marked in 1/2 cms. on it, puncture the lateral ventricle at a spot not far from the longitudinal fissure and drain off slowly a small quantity of fluid and at the same time note the depth of the ventricle from the surface. Remove the exploring needle—it has served its purpose of relieving tension and showing the distance of the ventricle from the surface.

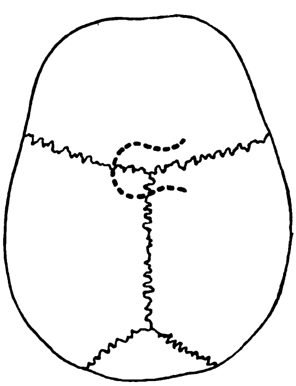


FIG. 30.—Payr's operation. (*Payr.*)

4. Have an assistant make a long incision over the long saphenous vein and by sharp dissection remove a segment of it. There must be no bruising of the vein. The length of the vein requisite must be from 50 per cent. to 60 per cent. longer than the distance from the longitudinal sinus to the ventricle as the excised vein shrinks very markedly. When excised place the vein on gauze soaked in warm salt solution and keep it warm. Note and remember which is the proximal end of the vein as that is the end which must be sutured to the sinus in order to take advantage of the valves in the vein.

5. Penetrate the ventricle with an aluminum trocar (2 to 3 to 4 mm. in diameter) which has a ½ cm. scale marked on it. Permit the fluid to escape very slowly; a plug of cotton in the trocar permits the fluid to escape in drops.

6. At least 2 to 3 cm. of the longitudinal sinus is exposed. Lift up the two dural flaps made in Step 2. This permits one to see the falx under the sinus. With semiblunt needles threaded with thin elastic or with a thin rubber tube perforate the falx anteriorly and posteriorly to the exposed segment of sinus. In this manner an elastic band goes from side to side under the sinus—one in front and one behind the site of proposed anastomosis—and when fixed by a stitch to the scalp on each side of the sinus these exercise pressure on the sinus and so stop the circulation temporarily.

7. To the right and to the left of the site chosen for anastomosis introduce and tie a suture of fine silk which penetrates only the external tunics of the

sinus. Leave the ends of these sutures long. If bleeding takes place when the sinus is incised it can be promptly stopped by crossing the sutures.

8. Incise the sinus and introduce into it obliquely and backwards the proximal end of the excised long saphenous vein. It is wise to have the end of the vein folded back like a cuff so that any part of it which may protrude into the sinus is covered with endothelium. With fine silk sutures fix the vein to the opening in the sinus and as supporting sutures tie together gently the two threads introduced in Step 7.

9. Remove the aluminum trocar from the ventricle and push the free end of the segment of vein along its course into the ventricle. This may be done with a stillette of stiff silver wire. It is well to have the end of the vein turned back on itself in cuff fashion.

10. Remove the elastic constrictors from the sinus. Close the dural wound. Close the cranial-scalp wound.

Several observers have noted that when drainage has been established between the ventricles or the meninges and the cellular tissues, absorption of the fluid was at first satisfactory but that later the cellular tissues refused to continue absorbing the fluid and encysted it instead. A. H. Ferguson drilled a hole through the body of the fifth lumbar vertebra and passed a silver wire through it from the spinal to the peritoneal cavity. Nicoll proposed the following steps: laminectomy; resection of a transverse process; insertion of a tube (decalcified bone, glass) from the spinal meninges to the peritoneum; instead of inserting a tube Nicoll has sutured a tag of omentum to the meninges.

Heile has sutured the meninges to the peritoneum of the large intestine. Harvey Cushing has endeavored to establish drainage between the meninges and the neighborhood of the peritoneum. The following is quoted from Cushing's article in Keen's Surgery: "It is essential in the first place to determine if possible where the obstruction lies, for if it is evident that the foramina of Magendie and Luschka are occluded, some method of direct ventricular drainage must be resorted to. As the *first step* a lumbar puncture is performed, the tension of the fluid is registered, and if an amount sufficient to demonstrate that it must come from the ventricle can be withdrawn, the needle is removed and the fluid analyzed.

"The *second step*, carried out some days later, is to determine whether the child will withstand the withdrawal of a large amount of fluid, for though I have never seen convulsions, collapse, etc., from this source, such accidents have been recorded by Keen and others. To do this, a combined puncture of the lumbar region and ventricle is performed. A long glass tube of small calibre connects, by a short rubber tube, with each needle, and the fluid, when lumbar or ventricular space has been entered, spurts up into the tube to its tension level, about which it fluctuates with the cardiac and respiratory rhythm. If the foramen of Magendie is open the fluid seeks the same level in both tubes, and when either of them is dropped and the fluid allowed to escape the level in the other falls. Thus, the ventricle may be emptied by either tube—rapidly by the ventricular,

slowly by the lumbar—and I have withdrawn in this way from the lumbar subarachnoid space alone as much as a litre of fluid. The tubes are then withdrawn, the small scalp wound closed, dressed, and the fluid allowed to reaccumulate. A comparative chemical analysis of the fluid taken from the two sources should show them to be the same. When thus demonstrated that the ventricular fluid already communicates by natural channels with the subarachnoid space, it becomes evident that an additional operative communication between ventricle and the subarachnoid spaces over the hemisphere is superfluous and unavailing. The indication is clear that one must find some other means of escape for the fluid, and I have attempted to drain into the retroperitoneal space as follows:

"*Third Step.*—It having become established (1) that the ventricle can be emptied by the lumbar route and (2) that the withdrawal of fluid is not pre-

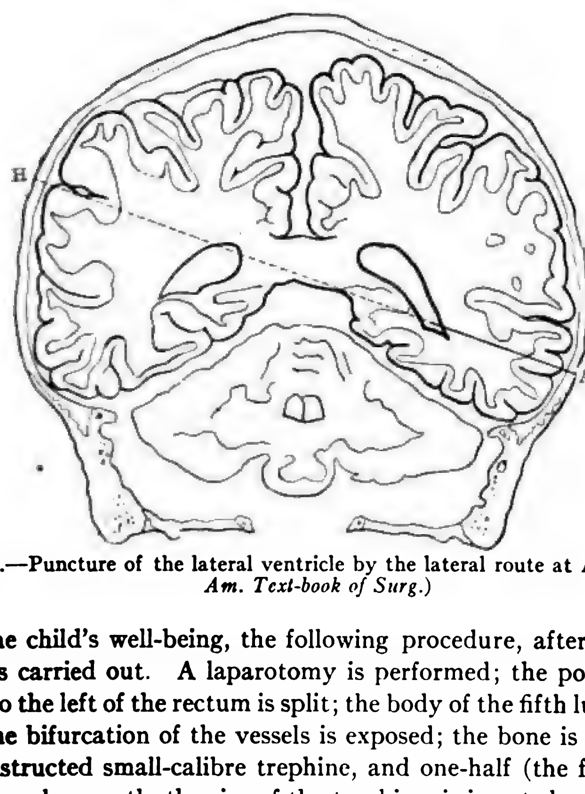


FIG. 31.—Puncture of the lateral ventricle by the lateral route at A. (*Keen, Am. Text-book of Surg.*)

judicial to the child's well-being, the following procedure, after an interval of some days, is carried out. A laparotomy is performed; the posterior layer of peritoneum to the left of the rectum is split; the body of the fifth lumbar vertebra just under the bifurcation of the vessels is exposed; the bone is trephined by a specially constructed small-calibre trephine, and one-half (the female portion) of a silver cannula, exactly the size of the trephine, is inserted and held in position. The child is then turned on its face and a laminectomy is performed; the subarachnoid space is opened, the strands of the cauda separated, and the posterior half (male portion) of the cannula is invaginated, so that it locks into the portion inserted anteriorly. Both wounds are then closed. The fluid for a time finds its way into the peritoneal cavity, but ultimately only into the retroperitoneal space, whence it is taken up by the receptaculum chyli, as

experimental observations have shown. It can be seen that this combined lumbar method is especially desirable in cases of hydrocephalus complicated by spina bifida, a radical cure of which may be made in association with the posterior part of the operation. I have carried out this procedure, which is briefly recorded here for the first time, in twelve cases, with a considerable measure of success."

ACUTE HYDROCEPHALUS, DRAINAGE OF LATERAL VENTRICLE

Keen's Method.—(A) Choose a point 1¼ inches above the upper margin of the external auditory meatus and the same distance behind the meatus. Open the skull at this point with a ½ inch trephine. On the opposite side of the head choose the point H (Fig. 31) 2½ to 3 inches above the meatus auditorius. Through the trephine opening pass a grooved director or fine cannula towards the point H. The cannula should reach the ventricle at a depth of 2 to 2¼ inches. If drainage is required introduce some threads of horse-hair or a fine tube of rubber.

OPERATIONS IN CASE OF EPILEPSY

I. Idiopathic Epilepsy.—(A) *Prophylactic Treatment.*—The report of results obtained in Körte's clinic (see p. 16) in cases of complicated fractures of the skull very strongly indicates the propriety of restoring the integrity of the skull after operations or fractures. The methods of doing this are discussed elsewhere (see p. 11).

Prophylactic treatment resolves itself essentially into the avoidance of local irritation and obtaining the most complete repair feasible.

(B) *Operative Treatment.*—The name idiopathic epilepsy is used as a cloak for ignorance and to denominate the non-focal forms of the disease. Many operations have been performed for the cure of the disease; the results have been good, bad and *nil;* negative results being the rule. The fact that many operations on regions apparently unconnected directly with the head have been followed by symptomatic cure of the disease led J. W. White to speak of "operations *per se*" being occasionally curative. Undoubtedly it is good practice to correct possible sources of irritation in epileptics, such as eye-strain, tight foreskin, decayed teeth, etc.

After shaving the head, scars will commonly be found on the scalp, even when no history of trauma has been elicited. Many of these scars are undoubtedly the result of accidents directly due to the epilepsy, but as undoubtedly, in occasional cases, one of the scars is the visible evidence of a trauma which occasioned the epilepsy. All such scars should be carefully examined as regards (*a*) tenderness to touch or to percussion, (*b*) mobility or adhesion, (*c*) condition of periosteum or bone, (*d*) the production of vasomotor or psychic symptoms on manipulation.

Keen is so strongly convinced that a scar of the scalp may be the cause of

epilepsy that after having excised the scar and having found the bone without evidence of injury, he closes the wound and waits; if excising the scar fails to cure, he then—and not until then—considers the advisability of performing some other operation.

Friedrich, in traumatic epilepsy, chooses the site of trauma as the site for operation even when the "aura" would indicate some other location as the starting-point of the epileptic explosion.

Kocher, believing increased intracranial pressure to be the important etiologic factor in idiopathic epilepsy, trephines and excises the dura over the right fronto-parietal region, as a rule; to this he sometimes adds drainage of the lateral ventricle.

Friedrich's results ("Archiv für klin. Chir.," lxxvii, Hft. 3) in eight cases kept under observation for years after operation show one case cured of epilepsy and coincident mental disturbances; two cases of very great improvement; one of improvement; one of temporary improvement; three unimproved.

If not guided by the evidences of old trauma Friedrich follows Kocher and operates over the posterior portion of the frontal lobes (right).

The operation is as follows:

Step 1.—Reflect a large flap of scalp, having its pedicle below. Open the skull and *excise* with forceps or other instruments a segment of bone. The size of the segment of bone removed varies from 20 to 48 sq. cm. (8 to 19 sq. in.).

Step 2.—Very carefully remove an area of dura varying in size from 9 to 33 sq. cm. (3½ to 13 sq. in.). Do *not* injure the subjacent pia. Avoid as far as possible all hemorrhage.

Step 3.—Replace the flap of scalp and suture. Apply dressings.

C. H. Mayo has had some success after operating as follows: Reflect a large osteoplastic flap; cut the fractured edges of the bone smooth. Reflect a flap of dura corresponding to the osseous defect. Push the dural flap into a pocket between the scalp and the bone (Fig. 32). Replace the osteoplastic flap, the bone of which lies next to the pia arachnoid. The dural flap acts as a drain between the meninges and subcutaneous lymphatics. Cushing's decompressive operation may be employed.

Although all such operations are perfectly justifiable under proper conditions, yet the surgeon must not be too sanguine as to results. Almost any operation is frequently followed by a temporary cessation of epileptic seizures, but recurrence is the almost invariable rule. Jonnesco's method of sympathectomy cannot be considered of proved value.

II. Focal or Jacksonian Epilepsy.—In focal epilepsy the irritation seems to originate in some particular point on the surface of the brain and to radiate to other parts. The parts affected are those which have been mapped out in the study of cerebral localization. The causes of this condition are numerous. Depressed fracture, osteophytic growths, neoplasms, localized meningitis causing adhesions, hemorrhage, abscess, etc., are all efficient causes and ought to be removed or corrected. If no macroscopic lesion can be found when the skull is opened and the brain exposed, the precise area from which the attacks radiate

may be defined by means of stimulation by weak electrical currents. The gray matter of this area, plus the pia mater covering it, may be excised. Of course, excision of an area of cortex means paralysis of the regions controlled by this area, but the paralysis seldom remains permanent. Immediately after the operation there is often a very temporary paralysis of parts supplied by neighboring centres. A few good results have followed cortical excision, but the rule is that epilepsy recurs when healing takes place. If a scar is removed from the brain, another scar is necessarily formed in the process of repair. There is a great difference, however, between the scar resulting from a clean incision or excision and one resulting from a coarse trauma or from inflammation. Covering a cerebral wound with celluloid, goldfoil, or rubber tissue prevents adhesion between the brain, meninges, and scalp or skull, and is a useful precaution. An implant of fat may also be of service.

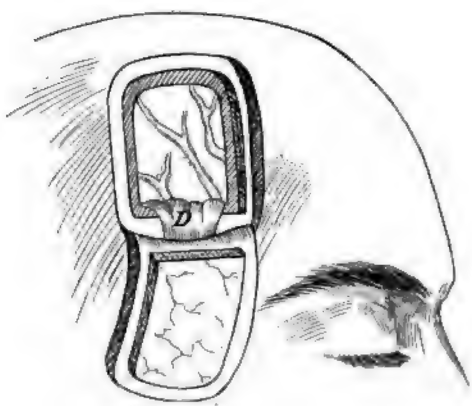


FIG. 32.—C. H. Mayo's dural drainage.

Carl Beck's Operation.—In some cases of epilepsy ("Annals of Surg.," Aug., 1906) due to adhesions at the site of a hiatus in the skull, the result of fracture or operation, Beck has obtained some good results by plugging the skull defect with temporal muscle and fascia, the fascia being placed next the brain or dura.

The Operation: Step 1.—Make the ∩ incision ABC (Fig. 33) and reflect the flap or scalp thus formed. This exposes the defect in skull. Carefully remove all scar tissue and exostoses from the defect and its surroundings. This means usually removal of dura. With chisel or rongeur remove enough bone from around the defect so that an edge of intact healthy dura is exposed. Attend to hemostasis.

Step 2.—Continue the incision BA to D and BC to E, and reflect the flap DFE. This flap must consist of scalp alone; the temporal fascia ***must*** be left intact.

Step 3.—Form the flap HKI consisting of temporal fascia, temporal muscle and pericranium, and having its pedicle towards the skull defect. This flap must be large enough to completely fill the defect. Turn the flap HKI upwards

and place it in the skull defect, the temporal fascia lying on the brain. Suture the temporal fascia to the dura.

Step 4.—Attend to hemostasis. Replace the flap DEF and fix it with sutures, providing for drainage, if necessary. Apply dressings.

In cases similar to those for which Beck devised his operation other surgeons reflect the scalp, remove scar tissue, etc., at the same time excising scars in the dura and freshening the edges of the bony hiatus. The usual methods of endeavoring to prevent fresh dural adhesions have been described elsewhere. Finsterer replaced destroyed dura with a portion of a hernial sac placed with its serous surface towards the brain. The sac, obtained during an operation for hernia, had been preserved in a 2 per cent. formol solution but was thoroughly

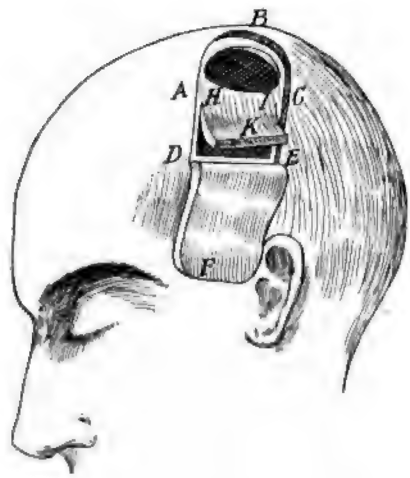


FIG. 33.—Beck's operation for traumatic epilepsy.

washed in normal salt solution before use ("Beiträge z. klin. Chir.," lxvii, 193). In experiments made on dogs Finsterer found that such peritoneal grafts preserved their vitality (?) and did not contract adhesion to the subjacent brain.

Perthes (German Surg. Congress, 1912) has used fresh hernial sac after Finsterer's method in seven cases, with success in six, and death in one due to infection secondary to a meningeal fistula.

Hanel ("Archiv für klin. Chir.," xc, 823), stimulated by Morris' recommendation of Cargile's membrane, prepared material from the intestines of sheep as follows: Bend a glass rod so as to make a four-sided frame; split open and stretch on the frame a segment of sheep's intestine. Soak in a 4 per cent. solution of formalin for twelve hours; wash in running water twelve hours; boil in water for ten minutes; preserve in the following solution: sublimate 0.8, glycerine 40.0, alcohol 800.0. Hanel used this material in the same manner as Finsterer uses hernial sac and Morris uses Cargile membrane. Hanel's membrane is absorbed after the lapse of about two or three weeks.

Kirschner ("Archiv für klin. Chir.," xcii, 894) recommends the use of fascia in covering dural defects. He obtains the material by excising a sufficiency of the fascia lata from the patient himself and after cutting away all fat from it places it over the dural defect and pushes its edges under the skull between the dura and the bone. At the German Surg. Congress, 1912, he reported seventeen cases from Körte's clinic. He writes: "(1) In all the cases the transplanted fascia healed without reaction.

"(2) In the cases where the implantation was made to replace dura pathologically affected in cortical epilepsy, there were no more convulsions." (Too short a time has elapsed to permit of final conclusions.)

"(3) When diseased dura was widely excised, water-tight closure of the subdural space was at once obtained by implantation of fascia. No meningeal fistulæ developed.

"(4) When operation is imperative in circumstances where the external wound cannot, with certainty, be rendered clean, the implantation of fascia hinders infection of the cerebrospinal fluid." (To the author this appears very dubious in view of the necessity of absolute asepsis when implanting any foreign material, even autoplastic.)

"(5) When much dura and bone are both removed the implanted dura prevents cerebral prolapse."

Lexer in a case of traumatic epilepsy, after excising an old scar uniting the meninges to the soft parts, implanted a free (non-pedunculated) flap of fat between the brain and the scalp. The result was very happy. In a case in which pain and giddiness resulted from adhesions between the meninges and scalp, the author followed Lexer's method and implanted a free flap of fat obtained from the patient's abdominal wall. The result was very satisfactory.

HEMORRHAGIC PACHYMENINGITIS

Bullard and John C. Munro have made strong pleas for the consideration of hemorrhagic pachymeningitis as a surgical condition demanding operation. The disease, when not found in infants or the insane, is one belonging to the later years of life. Alcoholism, syphilis, acute and wasting diseases, as well as trauma, seem to have some causal relation to the disease. The symptoms are those of diffuse subdural hemorrhage, coming on slowly, producing mental irritation, spasm, paralysis, the sequences being more or less irregular. The cranial nerves are not liable to be affected. Without relief by operation the prognosis is practically hopeless; with operation, it is still very poor but better than without. One of Munro's cases recovered; it was that of an alcoholic sixty-two years of age, picked up on the streets unconscious. On admission to hospital he could not be roused. There was no bleeding from the mouth, nose, or ears. Temperature was normal, pulse 80; right knee-jerk absent; no rigidity; hematoma in right parietal region. Trephined on right side; no pulsation of dura, which was bulging and dark blue. Subdural clot covering the whole hemisphere removed. Trephined on left side; a diffuse, thin clot was found

and removed. Towards the close of the operation consciousness returned. The result was complete recovery. In another case failure to trephine on both sides led to death, though immediate improvement followed the operation.

HYPOPHYSECTOMY

Attempts have been made to cure or relieve patients suffering from hyperpituitarism (acromegaly) and hypopituitarism by excising the hypophysis (pituitary body) either completely or incompletely. The pituitary body lying as it does in the *sella turcica* may be approached from above and the side through the cranial cavity or from in front and below.

A. Operation from Above.—Horsley approaches the hypophysis very much as one does the Gasserian ganglion. On the right side he makes a large opening as in the Hartley-Krause operation, then lifts up the temporo-sphenoidal lobe with broad retractors until the tumor is seen lying in the *sella turcica*. The tumor when exposed is incised and its solid contents are scraped away.

Bogojawlensky's Operation.—("Zent. für Chir.," No. 7, 1912).

Stage 1.—From a point 2½ cm. (1 in.) external to the middle line of the forehead and the same distance above the upper margin of the orbit make a cut upwards for about 9 cm. (3½ in.), then continue the cut backwards for 9 cm. and downwards for the same distance. Along the line of the scalp incision divide the bone with forceps, saw or surgical engine. A large Hartley-Krause flap with pedicle below is thus outlined. Attend to hemostasis and apply dressings.

Stage 2.—After several days or weeks elevate and reflect downwards the outlined flap of bone and scalp. Raise the head end of the table to 30°. Let the patient's head hang backwards over the end of the table. The raising of the head end of the table prevents loss of cerebrospinal fluid. Make an H-shaped incision through the dura and reflect the dural flaps thus formed. With finger and brain spatula slowly and carefully lift the frontal lobe from the roof of the orbit. The dependent position of the head permits the weight of the brain to aid in this maneuvre so that it is not necessary to apply retractors to the brain, and the optic commissure and any tumor of the hypophysis become visible and accessible.

McArthur's Method (Trans. Surg. Section A. M. A., 1912).

1. Place the patient in Bogojawlensky's position. Make the incision **ABCD, Fig. 34,** penetrating to the bone. The incision AB is 3 to 4 cm. (1⅛ to 1¾ in.) long. Reflect the flap (including the periosteum) upwards. **With an elevator** introduced through the wound CD separate the periosteum from the orbital roof and displace the orbital contents downwards using a teaspoon as a depressor. The periosteum being kept intact the orbital contents are not seen.

2. With a ¼ inch trephine penetrate the frontal prominence 4 cm. (1½ in.) above the middle of the supra-orbital arch. Preserve the button of bone in warm salt solution. Beginning at the trephine opening with DeVilbiss

forceps make a curvilinear cut through the bone, concavity downwards, the inner end terminating at the frontal sinus, the outer at the outer aspect of the external angular process, thus invading somewhat the temporal fossa. With an osteotome divide the outer wall of the frontal sinus. Divide the external angular process. Elevate and remove the loosened frontal fragment; preserve it in warm salt solution. With rongeurs cut away the orbital roof back close to the optic foramen, being careful not to injure the dura.

"With this completed one can slowly and carefully detach from the bone the dura covering the inferior surface of the frontal lobe, at the same time having the latter raised by a long thin angular retractor in the hand of a skilled assistant, in whose other hand a spoon retractor displaces the orbital contents downwards. When one has reached the anterior clinoid process and the free edge of the wing of the sphenoid, which can be recognized with probe, blunt hook or finger, orientation becomes easy."

3. Note the dura between the clinoid processes and make a 2 to 3 cm. (¾ to 1⅛ in.) transverse incision through it with a fine hook-shaped knife about 0.5 cm. (⅜ in.) above the level of the floor of the anterior fossa, thus avoiding "the small, transverse venous sinus that occupies the groove between the optic foramina (this groove it was long taught, harbored the optic chiasm)." Through the dural opening the optic nerve, chiasm and the pituitary tumor come into view.

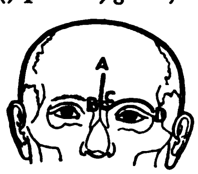


FIG. 34.—McArthur's incision for hypophysectomy.

4. Treat the disease by evacuating fluid or removing tumor tissue with a fine curette.

5. Permit the frontal lobe to fall back into place. Replace the bone removed. Replace the flap of soft parts, suturing the periosteum separately. Close the skin wound. Introduce a rubber tissue drain to the dura.

McArthur has found that but little scar or deformity results. His method is perhaps the safest and easiest means of performing an extremely difficult operation.

Frazier's method ("Annals Surg.," Feb., 1913) is almost the same as McArthur's. Reflect an osteoplastic flap from the right frontal region, the pedicle being lateral; remove the supra-orbital ridge *en bloc* with a portion of the orbital roof; remove with rongeurs the remainder of the roof of the orbit down to the optic foramen; elevate the frontal lobe; depress the orbital contents; incise the dura sufficiently to lay bare the cavity of the sella turcica (Fig. 35).

B. Operation from in Front and Below.—v. Eiselsberg's operation ("Annals Surg.," July, 1910).

Step 1.—Make an incision as in Fig. 36 down to the bone.

Step 2.—Divide the nasal bones with a chisel, the cartilage with a knife, the septum with scissors, and so reflect the whole nose to the right.

Step 3.—Remove the turbinate bones. With a chisel convert the anterior wall of the frontal sinus into a flap and reflect it upwards along with the frontal flap outlined in Fig. 37. Remove the vomer (Fig. 37).

Step 4.—With chisel and bone forceps remove the anterior wall of the sphe-

noidal sinus and expose the prominence of the hypophysis lying in the sella turcica.

Step 5.—Keeping strictly *in the middle line* penetrate the bony floor of the sella which forms the upper posterior wall of the sphenoidal sinus (Figs. 38 and 39). This may be begun with a chisel and completed with a fine bone nipping forceps or a punch.

Step 6.—Incise the dura covering the hypophysis. *Keep* in the middle line to avoid injuring the optic nerves and the cavernous sinuses.

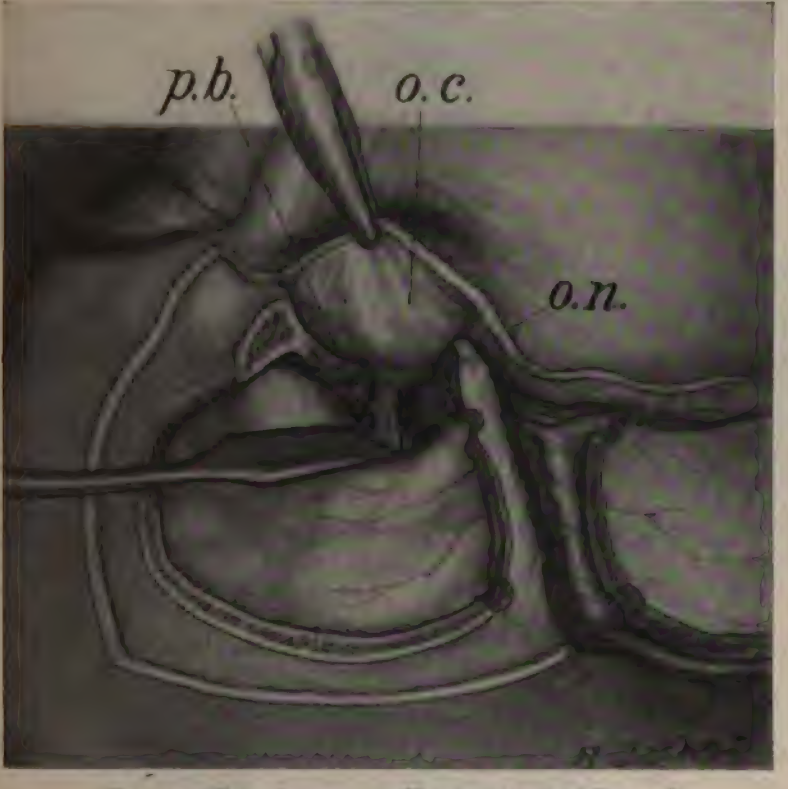


FIG. 35.—Hypophysectomy (*Frazier, Annals of Surgery.*)

Step 7.—Remove the tumor with a curette or evacuate any fluid if the disease is cystic.

Step 8.—Pack with a narrow strip of iodoform gauze.

Step 9.—Replace the nose and the anterior wall of the frontal sinus. Suture. v. Eiselberg has operated six times on the hypophysis and tabulates his results as follows: First group, hypopituitism, three cases, improved. Second group, acromegaly, two cases, both died. Third group, mixed type, one case, improved.

Kocher in operating does *not* open the frontal sinuses.

Hochenegg's Operation (Stumme, "Archiv für klin. Chir.," lxxxvii, 444).

Step 1.—Place a plug of gauze between the soft palate and the posterior wall

of the pharynx. Hold the gauze in place by tapes passed through the nose and mouth and tied in front (Fig. 40).

Step 2.—Make a skin incision from left to right over the root of the nose. On the right side continue the cut downwards along the side of the nose and around the right nostril. Through this incision divide the cartilaginous septum with scissors, the bony septum with forceps, and divide the nasal bones with a chisel.

Step 3.—From the original skin incision make two other cuts following the eyebrows both to the right and left. Through these cuts form, with a chisel, a

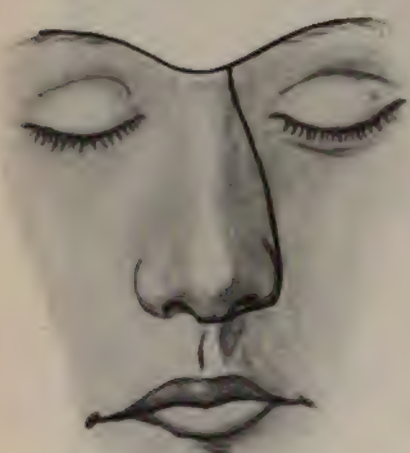


FIG. 36.—Hypophysectomy. (*v. Eiselsberg, Annals Surgery.*)

FIG. 37.—Hypophysectomy. (*v. Eiselsberg, Annals Surgery.*)

skin-periosteum-bone flap containing the anterior wall of the frontal sinus. Reflect the flap upwards.

Step 4.—Turn the nose to the left and remove its contents, viz., septum, turbinate bones, leaving intact the inner wall of the orbit and the wall of the antrum of Highmore. Use adrenalin tampons to stop bleeding.

Step 5.—Open the sphenoid sinus and proceed as in v. Eiselsberg's operation.

Kanavel ("Journ. A. M. A.," November 20, 1909) devised an intranasal route by which to expose the hypophysis and yet avoid all disfiguring scars. This operation he worked out on the cadaver, but it was first used on the living by A. E. Halstead ("Surg., Gyn., Obstetrics," May, 1910) who associated Kanavel with himself in the operation. Montgomery West ("Journ. A. M. A.," April 2,

1910) has devised a method similar to Kanavel's but does the work entirely through the nostril without dislocating the nose. Both Kanavel and West suggest that it may be well to operate in two stages; in the first stage clearing the way to the sella turcica (this may be done under local anesthesia), in the second stage removing the tumor.

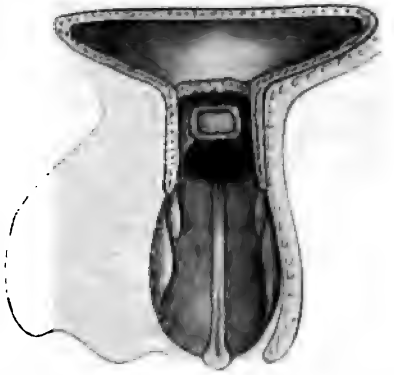


FIG. 38.—Hypophysectomy. (*v. Eiselsberg, Annals Surgery.*)

The following description is made up from the writings of Kanavel, Halstead and West and refers to operation completed in one stage.

Anesthesia.—After anesthesia is induced in the usual manner Kanavel continues the administration of ether by the rectal method, while Halstead performs tracheotomy and gives chloroform through a Trendelenburg cannula. To

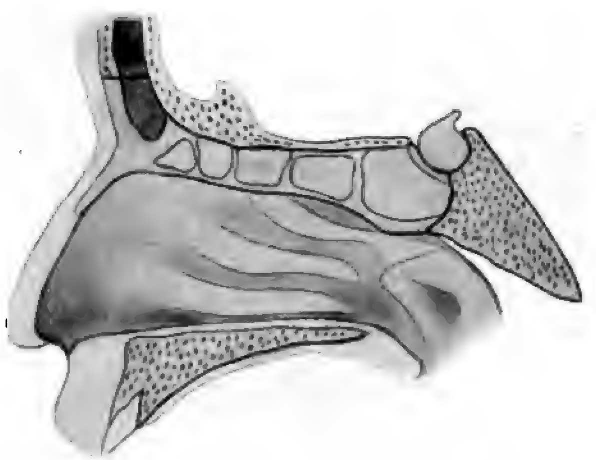


FIG. 39.—Hypophysectomy. (*v. Eiselsberg, Annals Surgery.*)

the author it seems that laryngotomy and the use of chloroform through Butlin's cannula is simpler and safer than tracheotomy. The advantage of anesthetizing through a tracheotomy or laryngotomy cannula over the rectal method consists in the ability to plug the pharynx thoroughly and the avoidance of all respiratory troubles. Before giving the anesthetic plug the nasal passages

carefully from the anterior nares to the sphenoidal cells with strips of gauze soaked in adrenalin solution.

The Operation. *Step* 1.—Tampon the pharynx. Remove the adrenalin pack. Raise the upper lip. Make a horizontal incision through the mucosa of the lip about 5/6 inch from the muco-cutaneous junction and parallel to the

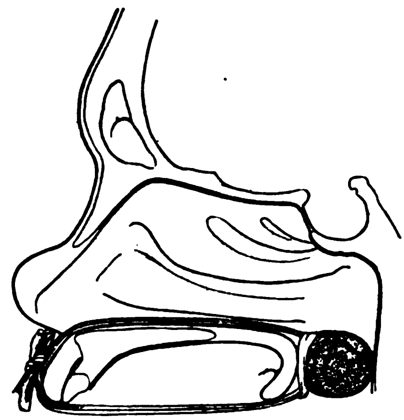


FIG. 40.—Hypophysectomy. (*Stumme, Archiv für Klin. Chir.*)

alveolus. Through this wound dissect upwards freeing the nose from its lateral attachments.

Step 2.—With strong scissors or bone forceps divide the septum along its inferior attachments (line b, Fig. 41). Divide the attachment of the septum to

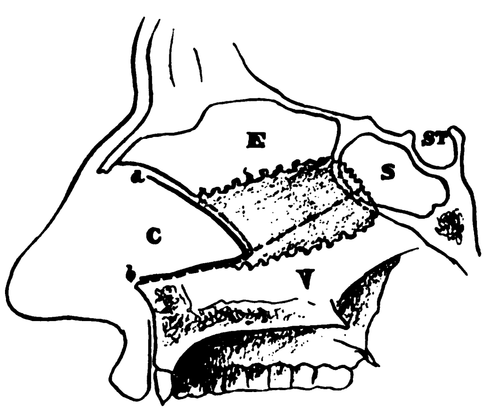


FIG. 41.—Hypophysectomy. (*Kanavel, Jour. A. M. A.*)

the vertical plate of the ethmoid (line a, Fig. 41). Turn the nose and with it the separated part of the septum upwards on to the forehead.

Step 3.—Remove the lower and middle turbinates, the vomer and the perpendicular plate of the ethmoid. The anterior wall of the ethmoidal sinus is now exposed.

Step 4.—Penetrate the anterior wall of the sphenoidal sinus. Sometimes the tumor will now appear having eroded the sella turcica. If this has not occurred, open the sella turcica by means of a long narrow chisel. While opening the sella turcica it is of prime importance to adhere strictly to the middle line for fear of damaging the carotid arteries and the optic nerves.

Step 5.—Treat the disease by evacuating any cyst which may be present or gently curetting away tumor tissues.

Step 6.—Pack the cavity with iodoform gauze. Replace the nose. Suture the septum. Suture the wound in the mouth.

Results.—The results of Kanavel's operations have been most excellent as regards absence of deformity. There has been no recognizable deformity in any of the patients submitted to operation.

The following surgeons have operated by the Kanavel method or some modification of it:

Halstead, A. E. "Surg., Gyn., Obst.," May 10), two, one death. Kanavel, two, one death. Mixter, S. J., one, no death.

In Mixter's case and in Halstead's successful case the results were most gratifying. Kanavel (personal communication), writes: "My first case lived about five weeks and then died from a recurrence. After the operation he had been up and left the hospital. My second case was one of the adipose genital type, and has remained perfectly well ever since the operation, which relieved him of all the symptoms of which he complained, and with the use of the anterior lobe of the pituitary gland he is now beginning to grow."

v. Eiselsberg has operated on the hypophysis six times; in only two of his patients was there acromegaly and in both of these death resulted. The other operations were successful.

Cushing, Hochenegg, Kocher and [illegible] have each operated once or twice by various methods and have had moderate success.

It must be remembered in considering statistics that the operation of hypophysectomy is new and that the patients who have submitted to the operation were usually in a very serious condition [illegible] in a late stage of disease.

As the technic of the operation becomes more developed and knowledge of the disease or diseases of the hypophysis becomes better, undoubtedly cases suitable for operation will be seen at an earlier stage of the disease and the results of surgical treatment will become very much better than at present.

CHAPTER III

FRONTAL SINUS

Operation on the frontal sinus is indicated in empyema of that cavity. Frontal empyema is usually a concomitant of some form of chronic rhinitis. Either as a preliminary or complementary step in the operation it is wise to remove the anterior portion of the middle turbinated bone in order to simplify drainage.

The Operation.—Shave the eyebrow. Clean the field of operation. Protect the eyes with aseptic pads.

Step 1.—From the root of the nose make a curved incision outwards, parallel to and 1/8 inch above the upper margin of the orbit. The incision extends to a point just external to the supraorbital notch and penetrates to the bone. With the periosteal elevator separate the soft parts from the bone until the outer wall of the sinus is exposed.

Step 2.—With a bur, small trephine, or gouge carefully remove the exposed wall of the sinus, immediately to the outer side of the middle line, above the root of the nose. Only a very small area of bone should be removed at this time, and care is necessary lest such an instrument as the chisel should suddenly penetrate the thin bone and injure the posterior or inferior walls of the cavity. As soon as the bone is penetrated, the mucosa lining the sinus pouts into the wound. Incise the mucosa. Gently explore the cavity with a probe and with gouge or forceps (guided by the probe) remove the anterior wall of the sinus. Some surgeons are careful *not* to remove any of the orbital margin lest an ugly deformity result; others carefully remove every particle of bone which might interfere with the soft parts being brought in absolute contact with the deep wall of the sinus, the aim being to obliterate the cavity. Obliteration of the cavity is often necessary, but as it causes marked deformity one is wise to try less mutilating procedures first.

Step 3.—With a sharp spoon remove all granulation tissue from the sinus and from its opening into the nose. With a small sharp spoon cleanse every nook and cranny. Be careful not to injure the orbital plate. Pass the sharp spoon from the postero-internal angle of the sinus downwards into the nose. The instrument goes through some of the ethmoidal cells and creates a good passage for drainage.

Step 4.—Pass a rubber tube from the sinus into the nose. Some surgeons do not permit the upper end of the tube to emerge through the skin, but close the cutaneous wound entirely, trusting to nasal drainage alone, as in Barth's operation; most operators place the tube so that it emerges both through the skin and the nose. Through-and-through drainage is probably best to begin with. During the after-treatment, if it becomes necessary to withdraw the tube tem-

porarily, it is well to fasten a thread to the tube, so that as the tube is withdrawn the thread may take its place and serve as a guide for the introduction of a clean drain. Close all excess of wound with sutures. Dress.

After-treatment.—Warn the patient not to blow his nose violently, otherwise emphysema will result. When nasal drainage alone is provided, leave the tube *in situ* as long as possible, because once removed it is very difficult to replace. When through-and-through drainage is provided, withdraw the drain gradually, through the nose, as suppuration lessens. When drainage fails to cure the disease, the sinus must be obliterated by the method indicated in Step 2.

Killian's operation is very radical and successful. (Freudenthal, "Jour. Am. Med. Assoc.," Feb. 11, 1905.)

Step 1.—Make an incision down to the bone the whole length of the eyebrow, just above the orbital margin. Continue the incision at its inner end down the middle of the nasal process of the superior maxilla.

Step 2.—Open and explore the sinus either above or below the orbital margin.

Step 3.—With chisel and mallet make a furrow through the bone immediately above and parallel to the margin of the orbit. Remove with forceps the whole anterior wall of the frontal sinus above the furrow.

Step 4.—Clean out the sinus and remove its mucous membrane.

FIG. 42.—Barth's operation.

Step 5.—Remove with forceps the whole (orbital) floor of the sinus, leaving the orbital margin intact for cosmetic reasons.

Step 6.—Resect the frontal process of the superior maxilla and the rest of the floor of the sinus.

Step 7.—Resect the anterior and middle ethmoidal cells and the respective parts of the middle turbinal. These structures are always affected.

Step 8.—Close the wound after providing for drainage by a rubber tube.

The extensive removal of the floor of the sinus and consequent opening of the orbit cannot be without danger. The inevitable entrance of pyogenic organisms into the non-resistant fatty tissues must often give rise to orbital abscess.

Barth's Operation.—A little to the side of the middle line at the root of the nose make a longitudinal incision one inch in length, down to the bone. With a chisel carry the above incision through the nasal process of the frontal bone and the nasal bone. At the upper and lower angles of the wound, by means of a narrow chisel, make horizontal cuts outwards through the bone. The flap of bone thus formed is pried outwards (Fig. 42) like a trap-door with hinge placed externally. The upper part of the opening is filled with the mucous membrane of the frontal sinus. Cut through this bulging mucous membrane. Through the above opening diseased tissue may be inspected and removed, free drainage through the nose may be provided, and if necessary the opposite sinus may be opened and treated. When the operation is completed, the bone-flap is restored to place and the vertical skin-incision is sutured.

CHAPTER IV

TIC DOULOUREUX

In severe cases of trigeminal neuralgia, after treatment by removal of sources of peripheral irritation and particularly of infection and by medicine has failed, operation offers the only hope of amelioration or cure. Very many operations have been devised, but not all of them are useful. The earliest operations consisted in the subcutaneous or open division of the nerve-trunks as they left or entered their bony canals. The supraorbital nerve was divided as it emerged from the notch of the same name, the infraorbital at the infraorbital foramen, and the inferior maxillary as it entered the posterior dental canal. In certain cases such operations gave marked and occasionally permanent relief, but after simple division of a sensory nerve repair can take place with great rapidity, so that the neuralgia usually recurs at an early date.

Thiersch, after exposing the nerves at their exit from their bony canals, seized them in strong forceps and by slow twisting and pulling, forcibly extracted a varying amount of them from their canal. Recurrence after this procedure was neither so prompt nor so constant as after simple division. Undoubtedly the best method of operating upon the nerve-trunks is by the removal of as much of them as is possible, or by injecting into them materials which will either destroy or diminish their power of conduction.

INJECTIONS INTO THE NERVES

Schlösser was the first to make injections into the trunks of the nerves at the base of the skull in treating trifacial neuralgia. Ostwalt followed him and injected the three branches of the nerve through the mouth. Lévy and Baudouin devised and systematized a simple and safe method for making the injections without incurring the dangers incident to invading the mouth. Patrick has followed their method with much success. The author has followed Murphy's modification of the Lévy-Baudouin procedure and finds it easy and satisfactory.

Ostwalt's Injections ("La Presse Méd.," Dec. 16, 1905).—Ostwalt injects 1 to 1½ c.c. of 80 per cent. alcohol (to which is added .01 cocaine or stovaine) into the trunk of each of the branches involved where it emerges from the skull. "As usually several branches (most commonly the second and third) are affected at the same time, I make an injection in two or three stages; first at the foramen ovale then at the foramen rotundum and last, if necessary, in the sphenoidal fissure. To reach the foramen ovale, I introduce my bayonette-shaped needle (Fig. 43), mounted on the syringe, behind the wisdom tooth and make it penetrate the mucosa, submucosa and external pterygoid muscle, then

I pass it up into the pterygoid fossa along the external wing of the pterygoid process until it strikes the great wing of the sphenoid. I then direct the point of the needle backwards into the angle formed by the pterygoid process and the great wing of the sphenoid until bony resistance disappears, and the foramen ovale is reached. As soon as the fluid is injected here I conduct the needle, always in the above-mentioned angle of the pterygoid fossa, forwards until once more the sense of bony resistance is lost. The needle is now at the border of the sphenomaxillary fossa. Keeping the needle continuously on the anterior surface of the pterygoid fossa I push the needle upwards 6 to 9 mm., reaching the foramen rotundum, and can feel the upper border of the foramen formed by the little osseous bridge which separates it from the sphenoidal fissure. In the rare cases where the first branch is involved along with the second or with the second and third branches, it is only necessary (once the injection of the superior maxillary is completed) to pass the needle about 2 mm. higher, passing above the little osseous bridge already mentioned, where it encounters the ophthalmic

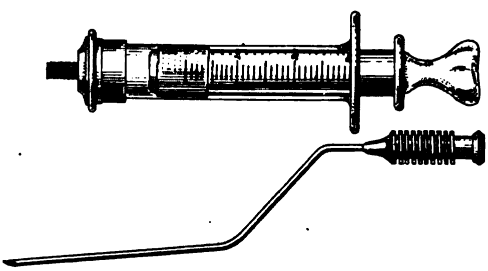


FIG. 43.—(*Ostwalt.*)

branch in its passing through the sphenoidal fissure." Ostwalt has made 250 deep injections in tic without any ill effect. In at least one-third of the cases there was recurrence at the end of four or five months, but these recurrences were less serious than the original tic and were relieved by one or two more injections. Although as a rule one injection gives improvement in tic, yet two, three or four seances are generally required.

Lévy and Baudouin write ("La Presse Méd.," Feb. 17, 1906): "We have used, experimentally and clinically, alcohol and chloroform in which we have dissolved sublimate or carbolic in the proportion of 1 per cent." [One per cent. of sublimate is evidently a mistake—Author.] "We do not employ osmic acid for fear of necrosis. The following is our practice. We inject 1 or 2 c.c. of alcohol (with or without cocaine) of increasing strength—70, 80, 90 per cent.; then we repeat the injections of these strengths of alcohol after adding 4 drops of chloroform to each c.c. of alcohol. Experiments on animals show that these substances in the doses employed by us are harmless even when injected intravenously. The puncture itself is but slightly painful. Generally when the nerve trunk is reached the patient complains of a pain through the corresponding territory. . . . The injection should be made very slowly and the needle ought not to be withdrawn for fifteen or twenty

seconds. . . . After from two to five minutes the patient complains of a feeling of stiffness, of swelling, then of numbness in the territory of the injected nerve. Sometimes one can demonstrate a complete anesthesia which may persist for a long time. Usually the injection is followed by an exacerbation of the pain for some hours and the patient ought to be warned of this. In the region of the injection there is a slight temporary edema and after injection of the inferior maxillary nerve there is a certain difficulty in opening the mouth. As a rule six or eight injections are required at intervals of three or four days. The tolerance of the patient must regulate the time and strength of the injection. Experience has taught us that it is necessary to inject at least two of the branches of the trifacial nerve. In case of neuralgia of the inferior maxillary or of the ophthalmic nerves, the superior maxillary ought also to be injected. In case of neuralgia of the superior maxillary we inject the inferior maxillary also." J. B. Murphy uses from seven to fifteen minims of a 2 per cent. solution of osmic acid as an injection material. The author has had the pleasure of seeing some of the excellent results secured by Murphy.

The Operation.—The only special instrument required is the Lévy-Baudouin cannula. The cannula is of steel 10 cm. long, 1½ mm. in diameter (Fig. 44), and is graduated in centimeters. The mandrin with which the cannula is

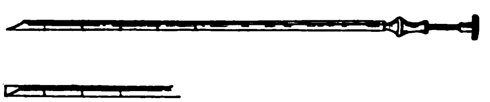


FIG. 44.—Lévy-Baudouin cannula.

provided, when pushed home protects the short point of the cannula so that no injury can be inflicted on such structures as arteries.

A. Injection of the Inferior Maxillary Nerve.

1. *Lévy-Baudouin Method.*—Note the bony prominence at the junction of the zygoma with the anterior bony wall of the external auditory meatus. Choose a point on the lower edge of the zygoma 2.5 cm. anterior to the above bony prominence. At this point introduce the cannula directly inwards and immediately under (in contact with) the zygoma for a depth of 4 cm. when its point must be at the foramen ovale. To avoid injuring the middle meningeal artery, push the mandrin home in the cannula (thus rendering the instrument blunt) as soon as a depth of 1.5 cm. is reached, retire the mandrin when the depth of 4 cm. is attained, and inject the chosen solution.

2. *Murphy's Method.*—Choose a point at the middle of the *upper* edge (Figs. 45 and 46) of the zygoma and here introduce the needle passing it directly inwards until it strikes either the squamous portion of the temporal bone or the great wing of the sphenoid and guided by these passes inevitably over the foramen ovale at a depth of 1½ inches (4 cm.) from the outer surface of the zygoma.

B. Injection of the Superior Maxillary Nerve.

1. *Lévy-Baudouin Method.*—Prolong the line of the posterior border of the

scending (orbital) process of the malar bone to the lower edge of the zygoma nd insert the needle ½ cm. posterior to this point. Direct the needle inwards nd slightly upwards in a direction which would attain at the depth of the fora-

FIG. 45.—Injections for tic.

nen rotundum (5 cm.), the level of the inferior extremity of the nasal bone. When the needle has penetrated 5 cm. its point has reached the nerve where emerges from the foramen rotundum into the pterygo-maxillary fossa.

FIG. 46.—Injections for tic.

2. *Murphy's Method.*—Draw an imaginary line vertically downwards from he external angular process of the frontal bone; where this line crosses the nferior margin of the zygoma introduce the needle directly under the zygoma. ass the needle inwards and a trifle upwards until it impinges against the back the superior maxilla. Guided by the maxillary bone push the needle on

until its point has penetrated 1¾ inches (4½ cm.) or slightly more from the surface of the malar and has reached the foramen rotundum.

C. Injection of the Ophthalmic Nerve.

Lévy-Baudouin Method.—These authors write: "The first branch of the fifth pair dividing inside the cranium one cannot attack its trunk. Of the three branches the nasal is hardly accessible in the midst of the important motor nerves which surround it. To reach the frontal and lachrymal nerves the orbital route is indicated. As a path to the nerve we have chosen the external wall of the orbit at the level of the inferior extremity of the external angular process of the frontal bone. Inserted here the needle passes below the lachrymal gland and follows the periosteum without injury to the eye or to any important organ. At a depth of 35 or 40 mm. one makes the injection after withdrawing the mandrin. The patient ought to have his eyes closed. The needle has some difficulty in penetrating the outer portion of Tenon's capsule which is very thick."

Hugh Patrick has had much experience in the use of deep injections of alcohol for the relief of tic and makes some characteristically cautious and sensible remarks thereon ("Journal A. M. A.," Sept. 19, 1907), a synopsis of which is given here:

The number of injections necessary for relief depends on the accuracy with which the alcohol is placed. A single injection within the nerve sheath will stop the pain at once. A number of trials may be necessary before this can be accomplished. An injection *near* though not *in* the nerve is not without value because the alcohol "undoubtedly diffuses sufficiently to reach it. In such cases the relief comes after some minutes or hours and does not last long. Consequently I believe it is wise to continue the injections even though the patient is having no pain, until the characteristic sensory phenoma" (pain and feeling of swelling and stiffness in the area supplied by the nerve; analgesia in area) "announce marked action on the nerve." If pain returns there seems to be no objection to secondary injections. In conversation with the author Patrick gave the impression, no doubt correct, that a permanent cure could hardly be expected from injections; but the operation is trivial, usually gives at least temporary relief and may be apparently repeated indefinitely.

Fischer ("Münchener med. Woch.," 1907, No. 32) reporting the result of injections of alcohol in Erb's clinic for various neuralgias warns against their use in mixed or in motor nerves as dangerous consequences have arisen; yet Patrick and others have injected alcohol into the facial nerve with good results in facial spasm (not tic) without causing troublesome facial paralysis.

D. Injections into the Gasserian ganglion itself have been made not only to relieve the pain of tic but to produce anesthesia under which extensive operations have been performed.

Harris' Method.—*Step* 1.—Draw an imaginary line from the "incisura notch" (the deep notch in the external ear above the lobule and between the tragus and antitragus) to the lower border of the *ala nasi*. This line in the average skull corresponds to the lower border of the sigmoid notch. Mark out the lower

border of the zygoma, especially the tubercle in front of the glenoid fossa; the anterior margin of this tubercle is precisely 1 inch in front of the external auditory meatus. Draw a vertical line through the anterior margin of the tubercle. This line meets the *incisura-ala nasi* line practically at right angles. "A plane through this vertical line perpendicular to the zygoma and side of the cheek passes through the foramen ovale."

Step 2.—Choose a point on the *incisura-ala nasi* line 1/8 to 1/4 inch in front of the crossing-point of the two lines and there introduce the needle upwards, backwards and inwards. Harris writes: "My needle must be directed very slightly backwards in order to hit the plane through the tubercle line at the depth of the foramen ovale, which I have found to vary from 42 to 54 mm., according to the thinness or fatness of the cheek, and according to the narrowness or great width of the head of the individual. The angle of backward direction varies from 15° in thin-faced narrow-headed subjects to even vertically inwards in stout wide-headed people. Similarly the angle of upward direction varies rarely as much as 15° and it may be almost horizontal."

When the inferior maxillary nerve is reached the patient may complain of pain in the lower teeth and lip. Attach a syringe to the needle and inject about 1 1/2 c.c. of 2 per cent. eucaine solution. If the nerve itself has been injected there will be immediate anesthesia of the lower lip and chin and the rest of the operation will be practically painless.

Step 3.—Keeping the needle in the original direction, feel with its point for the foramen ovale. When the foramen is found push the needle onwards into the substance of the ganglion for about 1/4 inch. Attach a syringe to the needle and slowly inject a drop or two of alcohol. If the needle is in the ganglion considerable resistance to the push of the piston will be noticed, when another 1 to 1 1/2 c.c. may be injected a few drops at a time. During the injection test sensation on the forehead by pricking with a blunt pin; when a pin prick or pin pressure is no longer noticeable, stop the injection and slowly withdraw the needle. If when the injection is begun no resistance is felt to the push of the piston and if the patient instantly complains of severe pain at the base of the skull and back of the head, the needle is not in the nerve but in Meckel's cave and cerebrospinal fluid may escape through the needle. Under these circumstances withdraw the needle slightly and reintroduce it through the posterior portion of the foramen so as to keep its point within the substance of the ganglion. If the patient complains of sudden pain in the cheek and nose after the needle enters the foramen, it means that it has passed in front of the ganglion and has struck the root of the superior maxillary nerve before the nerve has reached the foramen rotundum. Harris uses nickelled-steel needles 3 inches and 3 1/2 inches in length and 1.25 mm. and 1.4 mm. diameter, provided with a stilet, and with a short sharp point bevelled at an angle of 20 per cent. The Lévy-Baudouin cannula—10 cm. long, 1 1/2 mm. diameter, graduated in centimeters and provided with a mandrin—ought to do well.

Härtel's Method. ("Zent. für Chir.," May 25, 1912).—A stylet passed from the "impressio trigemini" through the foramen ovale will reach the masseteric

region midway between the anterior margin of the ascending ramus of the lower jaw and the posterior margin of the maxillary tubercle; in 90 per cent. of skulls the stylet hits the upper alveolus in the molar region. The distance from the foramen ovale (extra-cranial) to the cheek is 5 to 6 cm.; from the outer surface of the skull at the foramen ovale to the impressio trigemini it is not less than 1.5 cm., averaging 1.9 cm. A needle passed up this line is so limited in its lateral movements that it cannot injure the cavernous sinus internally, the brain above or the carotid below the Gasserian ganglion.

Technic.—Use a very fine graduated canula 9 cm. long. Choose a point on the cheek 2 to 3 cm. behind the angle of the mouth. Anesthetize the skin here and introduce the needle upwards to pass between the ascending ramus and the maxillary tubercle until the infratemporal plane is reached. When the needle hits the hard, smooth temporal bone, feel or explore backwards with the point of the needle for the foramen ovale. Härtel uses the following important landmarks to direct the needle: Viewed directly from in front aim the needle at the pupil of the eye on the same side; viewed from the side aim it at the articular tubercle of the zygoma.

As soon as the third branch of the nerve is touched there is paresthesia or shooting pains in the lower teeth and the needle may be slowly pushed through the foramen ovale until the pain in the upper jaw is evident. Now inject as slowly as possible ½ to 1½ c.c. of 2 per cent. novocain-adrenalin solution. Anesthesia is immediate and lasts 1 to 2 hours.

NEURECTOMY OF THE FIRST DIVISION OF THE FIFTH NERVE

The first or ophthalmic division of the fifth nerve enters the orbit through the sphenoidal fissure and divides into three branches—the frontal, lachrymal, and nasal. The frontal nerve, the only branch of surgical importance, divides into the supraorbital and supratrochlear. The supraorbital leaves the orbit through a notch or foramen situated at the junction of the inner and middle thirds of the supraorbital margin. With it run the supraorbital artery and vein.

NEURECTOMY OF THE SUPRAORBITAL NERVE

Locate the supraorbital notch or foramen. Make a horizontal incision through the skin, parallel to and a little below the eyebrow. Separate the fibres of the orbicularis muscle. Expose the nerve as it passes through the supraorbital notch. Divide the orbitotarsal ligament. With a flat retractor depress the orbital fat. Follow the nerve backwards from the supraorbital notch, separate it from its surroundings, divide it as far back as possible, and remove all of it in front of the point of section. Close the wound with sutures. Dress.

A good modification of the operation is the following: Expose the nerve at its exit; isolate it for a short distance; seize its undivided trunk with a narrow-bladed hemostat; rotate the hemostat so that the nerve becomes wound around

the jaws of the forceps; reverse the direction of rotation. By repeating the manœuvers of rotation and working slowly and patiently almost the whole peripheral portion of the nerve and much of its central trunk can be extracted. (Thiersch.)

NEURECTOMY OF THE SUPRATROCHLEAR

The supratrochlear nerve is generally divided in the preceding operation, but occasionally it is missed and demands special attention. Draw an imaginary line from the angle of the mouth through the inner canthus of the eye. At a point a little below where a continuation of the above line crosses the eyebrow make an incision through the skin parallel to the fibres of the orbicularis muscle. Find the trochlea, which acts as a pulley for the superior oblique muscle. Locate the posterior portion of the superior oblique muscle. The supratrochlear nerve and its branch, the infratrochlear, lie upon the superior oblique muscle and may be separated from it by a strabismus hook and excised.

NEURECTOMY OF THE SECOND DIVISION OF THE FIFTH NERVE

Anatomy.—The superior maxillary nerve "commences at the middle of the Gasserian ganglion, and, passing horizontally forwards, soon leaves the skull by the foramen rotundum of the sphenoid bone. The nerve then crosses the sphenomaxillary fossa, and, taking the name of *infraorbital*, enters the infraorbital canal of the upper maxilla, by which it is conducted to the face" (Fig. 47).

"In the sphenomaxillary fossa an orbital or temporo-malar branch ascends from the superior maxillary nerve to the orbit, and two sphenopalatine branches descend to join Meckel's ganglion; while the nerve is in contact with the upper maxilla it furnishes the superior dental or alveolar branches; and on the face are the terminal branches" (Quain).

When the neuralgia is limited to the facial distribution of the nerve, the following operations may be performed:

(A) Locate the infraorbital foramen at the junction of the inner and middle thirds of the inferior rim of the orbit and about half an inch below it. It is on a line drawn from the supraorbital notch to a point between the two bicuspids. Make a curved transverse incision parallel and close to the lower margin of the orbit. Divide the orbicularis muscle in a direction parallel to its fibres. Expose the nerve as it leaves the infraorbital foramen (Fig. 48). Seize the nerve in forceps, and by traction and torsion extract as much of its trunk from its bony canal as is possible. In the same fashion extract as much of its terminal twigs as possible from the soft structures in which they run. It is extraordinary how much of the nerve can be removed in this manner if patience is exerted. This operation does not destroy the alveolar branches of the nerve. In an endeavor to prevent recurrence one may plug the bony canal with a bone peg, silver screw, rubber tissue, or amalgam.

(B) Expose the nerve as in Method A. Opposite the infraorbital foramen make a vertical incision (a) through the soft parts joining the horizontal incision

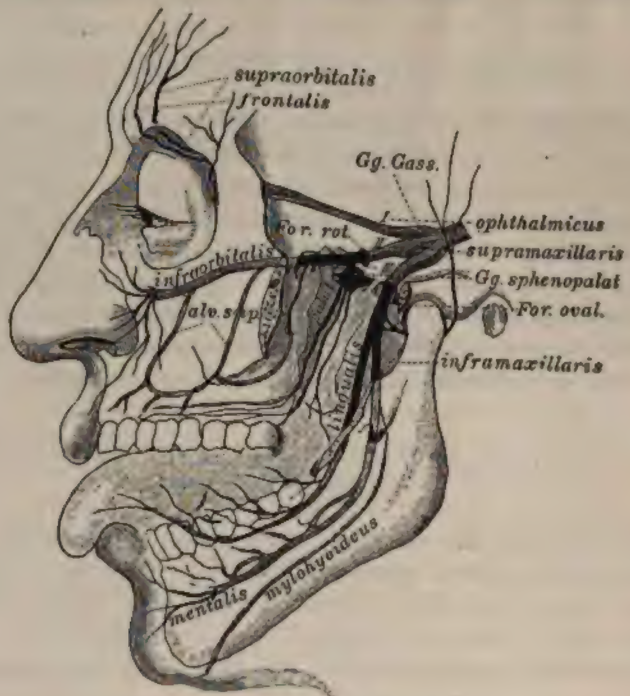


FIG. 47.—(*Esmarch and Kowalzig.*)

at right angles (Fig. 49). Divide the periosteum along the lower margin of the orbit. Separate the periosteum covering the floor of the orbit from the bone.

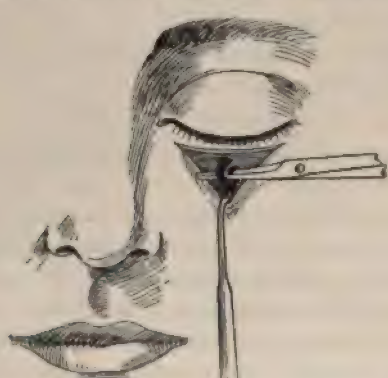


FIG. 48.—Evulsion infraorbital nerve.

If this is done, no orbital fat should be seen. With a flat retractor lift the orbital contents upwards (Fig. 50). With a narrow chisel cut through the bone all

round the infraorbital foramen and remove it until that part of the osseous canal which is covered by a thin shell of the bone forming the orbital floor, is exposed. With the chisel cut away the bony roof of the infraorbital canal to its posterior extremity. This can generally be accomplished without opening the antrum of

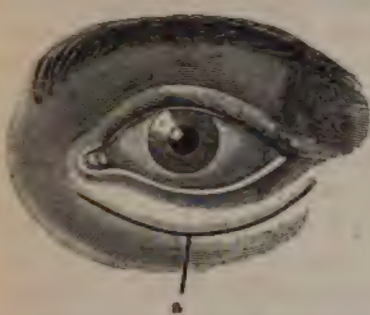


FIG. 49.

FIG. 50.

FIGS. 49 AND 50.—Excision infraorbital nerve. (*Esmarch and Kowalzig.*)

Highmore. Lift the nerve from its bed and excise it. Close the wound with sutures. Dress. The scar left by the operation is trifling. Several operations have been devised to excise the superior maxillary nerve and Meckel's ganglion by the antral route. Any operation in which the antrum of Highmore is opened is undesirable on the score of uncleanliness, and the advantages of such methods are more fully obtained by the operation about to be described.

FIG. 51.—Excision superior maxillary nerve. (*Farabeuf.*)

Pterygo-maxillary Operation. (Braun and Lossen's Modification of Lucke's Operation.)—*Step* 1.—Expose the infraorbital nerve at its exit from the bone.

Step 2.—Beginning at a point just behind and below the external angular process of the frontal bone, make an incision *backwards* and downwards to near the tragus. From the same starting-point make another incision downwards and *forwards* to the lower margin of the zygoma. Reflect downwards the triangular flap of skin and subcutaneous tissue thus outlined. With a finger saw, chisel, or Gigli wire saw divide the zygoma in front and behind. Rose recommends that before the zygoma is divided holes be bored on each side of the line of section so that everything may be ready for wiring the fragments in position on the completion of the active part of the operation. Separate the temporal fascia from the upper edge of the

zygoma and turn the bone downwards. Retract the tendon of the temporal muscle backwards. The pterygo-maxillary fossa is exposed, with its fat and plexus of veins. If one now pushes the fat back with a blunt retractor, one at the same time keeps the venous plexus and internal maxillary artery out of the way. Demonstrate the posterior orbital fissure with a probe or strabismus hook and distinguish the superior maxillary nerve and its accompanying vessel (Fig. 51). The course of the nerve from its exit from the skull is downwards, forwards, and outwards. The artery runs inwards, forwards and upwards.

Step 3.—Tie a ligature round the nerve for purposes of traction. Divide the central end of the nerve as close to the foramen rotundum as possible. By traction and torsion pull the peripheral end of the nerve out of its bony canal. By this operation the whole trunk of the nerve is excised from the foramen, rotundum to the cheek.

Step 4.—Attend to hemostasis. Replace the zygoma and fix it in position by wire or chromicized catgut sutures. Provide drainage. Close the skin wound. Dress.

NEURECTOMY OF THE THIRD DIVISION OF THE FIFTH

The inferior maxillary or third division of the fifth nerve leaves the skull through the foramen ovale and divides into an anterior, motor and a posterior division. The latter, almost entirely sensory, divides into the auriculotemporal, the lingual, and the inferior dental. The lingual and the inferior dental are of surgical importance, and as they are generally both involved, if either of them is affected by neuralgia, their excision may be considered as part of one operation. (See Fig. 47.)

The Operation.—Shave the temple. Clean the side of the face and the external auditory meatus, and plug the latter passage with a little gauze or better with non-absorbent cotton.

Step 1.—Beginning about the middle of the zygoma cut backwards and slightly downwards to a point a little below the tragus, then continue the incision downwards along the posterior margin of the ascending ramus to the angle of the lower jaw. From this point cut forwards along the inferior edge of the horizontal ramus for about ¾ inch. The cut only involves the skin and subcutaneous tissue. Reflect the skin-flap, outlined as above, forwards. The flap, consisting of skin alone, leaves the branches of the facial nerve uninjured. Note carefully the position of Stenson's duct and of the anterior lobules of the parotid gland. Make a transverse incision parallel to and below Stenson's duct, directly down to the bone, at a point about ½ inch below the sigmoid notch. Any portions of the parotid gland which may be in the way must be retracted backwards uninjured. With a periosteal elevator denude the outer surface of the ascending ramus of the jaw for a distance of one inch or more below the sigmoid notch.

Step 2.—Apply a ¾-inch trephine to the outer surface of the bone, the upper

edge of the trephine being not more than ¼ inch below the edge of the sigmoid notch (D, Fig. 52). With the trephine perforate the ascending ramus and remove the button of bone. With rongeur forceps remove the bridge of bone (C, Fig. 52), separating the trephine hole from the sigmoid notch. The result of the above manœuvres is to deepen the sigmoid notch while the coronoid and articular processes are left in uninterrupted connection with the rest of the jaw.

Step 3.—Retract the tendon of the temporal muscle forwards. With two pairs of dissecting forceps pick away any fat which may be in the way and demonstrate the external pterygoid muscle, which passes transversely across the wound from the outer surface of the external pterygoid plate to the articular process of the lower jaw. Note also the fibres of the internal pterygoid running downwards and backwards from the pterygoid fossa to the inner surface of the lower jaw near its angle. Retract upwards the lower fibres of the external pterygoid and thus expose both the lingual and inferior dental nerves, which, resting upon the internal pterygoid muscle, come out from under the external pterygoid and run downwards. The lingual nerve lies a little internal and anterior to the dental. Tie a ligature, for purposes of traction, round each nerve. Trace the nerves up to the foramen ovale and divide them there. Trace the nerves downwards and either divide them or by torsion and traction tear away as much of their peripheral portion as can be extracted. It is easy to remove more than an inch of the nerves.

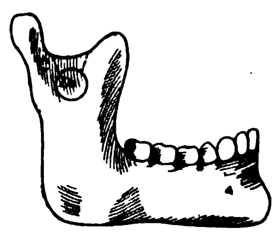


FIG. 52.—Excision inferior dental nerve.

Step 4.—Attend to hemostasis. Close the skin-wound. Drainage may or may not be used. Dress.

In certain cases of very painful cancers of the tongue relief may be secured temporarily, at least, by section of the lingual nerves.

Leriche (Lyon. Med., Jan. 18, 1914) agrees with Hayem that besides aerophagy due to a reflex having its origin at the level of the stomach certain cases are due to a primary hypersalivation. In one case of the latter after various régimes had failed to relieve, he divided both lingual nerves and the right auriculo-temporal nerve. The desired result was obtained; there was no longer hypersalivation, the aerophagy and its consecutive gastric disturbances disappeared. The patient was satisfied but complained of an impediment due to the lingual anæsthesia.

The simplest method of exposing the lingual nerve is through the mouth. Open the mouth widely. Pull the tongue forcibly to the opposite side so as to make the nerve stand out in relief below the mucous membrane of the tongue behind the last lower molar tooth. Make a ½-inch incision along the course of the nerve and after picking it up with a blunt hook excise as much as desired. The wound in the mucosa requires no sutures.

The auriculo-temporal nerve may be exposed by a ½-inch vertical incision midway betwen the tragus and the condyle of the jaw at the level of the posterior root of the zygoma. The nerve is posterior and parallel to the superficial temporal artery.

Inferior Dental Nerve. Transmaxillary Neurectomy.

Step 1.—From the angle of the lower jaw make an incision for about 1½ inches forwards along the lower border of the horizontal ramus. With an elevator separate the masseter from the bone. If necessary continue the incision upwards along the posterior border of the ascending ramus for about ¾ inch. Expose the greater part of the external surface of the ascending ramus.

Step 2.—Note the line of the free border of the teeth of the lower jaw and continue this as an imaginary line across the ascending ramus; on this line choose a spot midway between the anterior and posterior borders of the ramus and at this spot apply a Doyen's bur (about 16 mm. in diameter) and bore a hole sufficiently deep to expose the inferior dental canal and the nerve in it. The bur is a better instrument to use than a trephine as it is not so liable to injure the nerve.

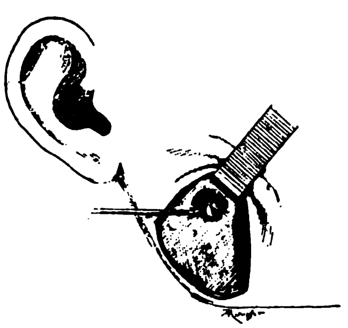


FIG. 53.—Excision inferior dental nerve. (*Lenormant.*)

Step 3.—The nerve is seen lying in the depth of the wound (Fig. 53). Pick up the nerve in a forceps and evulse it after the manner of Thiersch. Pack the bone canal with rubber tissue, hard paraffin, amalgam or some such material.

Step 4.—Close the wound.

The author has found this operation very satisfactory.

All the operations of neurectomy which have been described give at least temporary relief, but too frequently the *tic* returns after the lapse of a year or two. Occasionally the patient does not seem to get immediate relief from his pains. The author has in mind one case in which he removed portions of the inferior dental and lingual nerves. The patient suffered from neuralgia for one or two days after the operation. The pain was at once relieved on the removal of bloody fluid which had collected in the deep wound. Had the wound been efficiently drained, the temporary trouble might have been averted.

None of the operations of neurectomy for tic douloureux which have been described here are dangerous when performed by an experienced surgeon, but they are not a proper field for invasion by a tyro in surgery. In almost all the operations the wounds while large, are so situated as to cause but little deformity from scar, especially if the subdermal suture is used in closing them.

HARTLEY-KRAUSE OPERATION

It has been shown that tic douloureux very frequently recurs after even the most extensive excision of the nerve-trunks involved. It has also been shown (Keen and Spiller) that in the Gasserian ganglion very marked degeneration is present. When neurectomy fails to give permanently good results, it is most logical to attack the Gasserian ganglion. This has been done in many cases with excellent effect. The Gasserian ganglion may be exposed either from below or from above. The former method has been thoroughly studied by Rose, Andrews, and others. Their route entails temporary resection of the zygoma and the coronoid process, the use of the inferior maxillary nerve as a guide to the foramen ovale, exposure of the base of the skull beside that opening, the removal of a button of bone from the exposed portion of skull with a trephine, and lastly a rather haphazard removal of the ganglion when it is reached. Anyone who has had occasion to operate in the neighborhood of the foramen ovale can appreciate the difficulties of the operation. Hartley and Krause almost simultaneously devised a method of reaching the Gasserian ganglion by an intracranial route. Their operation is so much better than the others that it will be described here.

The Operation.—Shave at least one-half of the patient's head. Clean the head, face, and external auditory meatus. Pack the external auditory meatus with aseptic gauze or non-absorbent cotton.

Step 1.—As there are several methods of performing this step, they will be taken up seriatim.

Method A.—Beginning on the zygoma immediately in front of the tragus, make an incision upwards, directly to the bone. Make the incision run a curved course (convexity upwards) and end on the zygoma at a point about 1½ inches in front of the starting place. The curved incision outlines a flap 2½ inches in height, 2 inches wide at its broadest part, and having a pedicle 1½ inches wide. The flap is shaped somewhat like a uterus. Check the bleeding. With a chisel and mallet or a gouge, having a V-shaped cutting-edge divide the skull along lines corresponding to the wound in the soft parts. When the skull has been completely divided, raise the bone and soft parts adherent to it (skin, temporal muscle, periosteum) and turn them downwards, breaking the bridge of bone opposite the pedicle. The soft parts act as a hinge. The line of fracture where the bone-flap is reflected is opposite the zygoma, and hence is at a higher level than the base of the skull. With rongeur forceps cut away the bone immediately below the opening in the skull, until the true floor of the middle fossa of the skull is reached. This removal of bone after the bone-flap has been reflected is a very important step in the operation.

Method B.—Much time may be saved by using a circular saw or protected drill driven by an electric motor or surgical engine, instead of the chisel and mallet. Comparatively few surgeons possess such apparatus.

Method C.—Krause suggests the following method in cases where it is

imperative to avoid loss of blood. Have an assistant exercise pressure on the temporal artery. With a knife make an incision directly to the bone corresponding to the upper margin of the flap to be reflected. Through this cut separate the soft parts from the bone, with a periosteal elevator, down to the level of the zygoma. Rapidly make the anterior and posterior incisions of the flap. Attend to hemostasis. By the above means hemorrhage from the soft parts is avoided. Open the skull with a trephine. Remove as much bone with rongeur forceps as is reflected or removed in Method A. This method has a very limited application and leaves marked deformity, as no bone is replaced.

Method D.—Trace by an imaginary line on the temple the flap A, B, C, D, of similar shape and in the same position as that described in Method A. Join the points A and B (Fig. 54) by an incision, cutting directly to the bone. At the points A and B perforate the skull by means of a Doyen perforator or small trephine. With a dural separator raise the dura from the bone between the perforations. Pass a slightly curved grooved director between the dura and the bone from the opening A to the opening B. Along the grooved director pass a Gigli wire saw. The ends of the wire saw emerge at A and B. The loop of the wire lies against the inner surface of the skull between A and B. The cranial contents are protected by the director. Saw through the skull between A and B, cutting from within outwards. With a knife make the cuts AC and BD. Catch up all bleeding points in forceps as soon as they are observed. With narrow-bladed rongeur forceps (Dahlgren's, Keen's, etc.) divide the bone along the lines AC and BD. There is now a flap consisting of bone and superjacent soft structures which may be reflected downwards by breaking the bone along the line CD. The rest of Method D is identical with Method A.

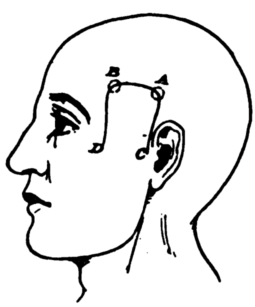


FIG. 54.—Hartley-Krause operation.

Step 2.—In the preceding step the bone has been removed down to the more or less horizontal base of the skull. With the finger *quickly* separate the dura from the bone until the foramen spinosum and middle meningeal artery are reached. Krause finds that quick work with the finger is without danger and produces less venous bleeding than slow separation with a blunt raspatory. However done, there is much venous bleeding which is stanched by pressure with gauze. When the foramen spinosum is reached (Fig. 55), gently lift the brain, covered by dura mater, with a spatula, whose blade, about 1¼ inches wide, is bent at a right angle. Usually the patient lies with his head more or less elevated. Pussep ("Russki Wratsch.," 1912, No. 10, "Zentralblatt für Chir.," 1912, No. 24) finds that when the patient's head is hanging downwards and somewhat to the side, the brain also sinks and then the wound cavity is wider and it is no longer necessary to retract the brain with a spatula. The disadvantage of this position lies in the probable increased venous bleeding. (See Bogojawlensky's position.) The brain is retracted sufficiently

to give a good view of the deep structures to be attacked. Isolate the middle meningeal artery at the foramen spinosum, doubly ligate and divide it. Often the artery runs in a very deep groove or even in a canal in the skull and therefore becomes torn while the bone is being removed. Again, the vessel may be torn at its exit from the foramen spinosum. In such circumstances bleeding may be stopped by pushing into the foramen or canal a thin strip of gauze by means of a blunt-pointed instrument. The end of the gauze strip must of course be brought out of the wound to allow of subsequent removal. Instead of gauze, catgut or Horsley's wax may be used. After attending to the middle meningeal artery continue sepaiating the dura from the bone in the direction of the ganglion. This is done with a blunt instrument or with small pledgets of gauze

FIG. 55.—Hartley-Krause operation. (*Krause.*)

held in hemostats. Bleeding is free, hence from time to time it is necessary to pack a little gauze underneath the flat retractor and press the gauze against the bone with the retractor for a few seconds. A slight change in the position of the retractor often causes the bleeding from the dura to cease. The ganglion having been reached, note that its upper surface is often firmly adherent to the dura. Separate these adhesions by blunt dissection. If the dura is injured, cerebrospinal fluid escapes but no harm results. Demonstrate the second and third divisions of the fifth nerve and divide them with a tenotome at the foramen rotundum and ovale respectively. Do *not* try to demonstrate the first division; it is in too close union with the cavernous sinus. If bleeding accompanies di-

vision of the second and third divisions of the nerve, it is easily stopped by pressure or by boring a blunt instrument into their foramina. Seize the posterior portion of the Gasserian ganglion transversely in the jaws of a hemostat. [It is well to do this after the second and third divisions have been isolated but not divided. After the ganglion is fixed by the forceps the two divisions of the nerve may be divided at their foramina.] With the forceps make traction along the axis of the nerve. This extracts the ganglion, and with it a longer or shorter portion of its root.

J. Hutchinson, Jr., advocates division of the superior and inferior maxillary nerves and removal of the corresponding portion of the ganglion, leaving intact the ophthalmic division and its portion of the ganglion (Fig. 56).

Step 3.—Replace the brain in position. Suture the temporal flap consisting of bone and superjacent soft structures, in place. Provide drainage if necessary and apply dressings.

Step 4.—For several weeks after the operation, danger threatens the eye of the side attacked, if for no other reason than that the eye, being rendered anesthetic, is subject to injury from dust, dressings, etc. Keen recommends keeping the eye clean by means of boracic-acid lotion, keeping the eyelid closed

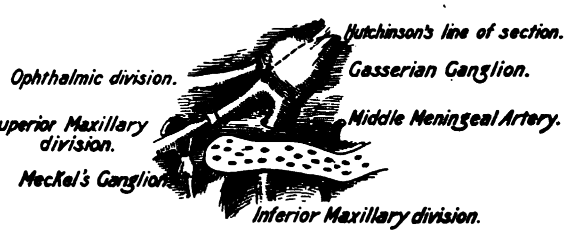


FIG. 56.—Left Gasserian ganglion exposed from the side.

by one or two stitches, so placed that while the eye is closed the boracic lotion may still be applied. The stitches are removed from the eyelids after two or three days and the eye protected by a watchglass shield held in place by adhesive plaster. These precautions seem entirely competent to prevent ocular trouble.

Occasionally when performing the Hartley-Krause operation free hemorrhage or the low condition of the patient demands that the operation be suspended. Under such circumstances the wound is packed with gauze, dressed, and the patient kept in bed for a few days, when the work may be resumed.

The Gasserian ganglion lies close to the cavernous sinus, and this structure has been wounded on more than one occasion, but the gush of blood has always been easily checked by gauze pressure. Fortunately the blood-pressure in the sinus is very low.

To gain a nearer approach and at the same time to avoid trouble from the middle meningeal artery Cushing exposes the Gasserian ganglion by a route lower than Hartley-Krause and higher than Rose. The method is similar to that of Poirier, but less severe.

CUSHING'S OPERATION

Step 1.—From a point ½ inch behind and slightly above the external angular process of the frontal bone a curved incision down to the zygoma, immediately in front of the ear. The highest point reached by the incision is two inches above the zygoma. Reflect the skin downwards. Resect the zygoma subperiosteally. Make a curved incision, parallel to the above, through the temporal fascia and muscle. Reflect these downwards, exposing the lower part of the temporal fossa.

Step 2.—With chisel or gouge open the skull at the most prominent part of the exposed great wing of the sphenoid. With rongeurs enlarge the opening until it is 1½ inches in diameter and extends down to and includes the ridge between the temporal and zygomatic fossæ. The middle meningeal artery lies on the dura, running obliquely across the opening in the skull, the lower part of which is on a level with the resected zygoma.

Step 3.—Lift the dura and the artery from the base of the skull until the [illegible] of the former at the foramen ovale is reached. Support [illegible] structures gently with a well-rounded, pliable spatula or retractor [illegible] inch wide, which should be held by the surgeon himself. Using the [illegible] maxillary nerve as a guide, split the sheath of the ganglion and [illegible] upper surface.

Step 4.—With a blunt dissector isolate but do not yet divide the three [illegible] of the trigeminus. Isolate the ganglion and its sensory root. Grasp [illegible] with a hemostat. Lift up the peripheral [illegible] divide them. Evulse the root with forceps. During [illegible] bleeding may be controlled by temporary pressure with [illegible] Krause, Brewer and others find that [illegible] results from [illegible] of the external carotid artery, as the most troublesome bleed- [illegible] It is a useless step, therefore, as the middle meningeal can [illegible]

[illegible]

bone, and enter the skull by a small trephine opening, rapidly enlarged by rongeurs to one and one-half inches in diameter. Expose the second and third branches from the Gasserian ganglion to the foramina. Seize each at the foramen by a narrow clamp, cut it, and resect a half-inch or tear it from the ganglion; push back the dura well beyond the foramina; arrest bleeding by a moment's pressure, and spread over the bone a piece of sterile rubber tissue, enough to more than cover both foramina, one inch wide by an inch and a half in length, which must be pressed upon the bone by a strip of gauze packed over it for a couple of minutes. When this is removed, the rubber tissue lies in close contact with the skull and the dura is allowed to settle down to its place upon it. The wound is then closed by a few fine catgut sutures and drained for a day at its lower angle." ("Trans. Am. Surg. Assoc.," 1903.)

G. R. Fowler has used Crile's plan of temporary occlusion of both common carotids and found it useful. In one case a tape passed round the carotid and secured by a clamp, pressed against the internal jugular vein and caused much venous oozing during the operation. Abbé's operation has given most excellent results, and seems in every way preferable to the infinitely more formidable excision of the ganglion.

When should one practise excision of the Gasserian ganglion? In cases of intolerable tic douloureux one should try the milder operations of neurectomy, as their death-rate is much lower than that of the major operation; they are, in fact, safe operations and good permanent results are sometimes obtained. Furthermore, the neurectomies give at least temporary relief, and so permit the strength of the patients to be built up. This is important, as the sufferers from tic douloureux are often much reduced from their long-continued agony. The Abbé operation being as successful as the Gasserian ganglion excision and not very much more dangerous than some of the extracranial neurectomies, ought, in many aggravated cases, to be given the preference over these.

CHAPTER V

PLASTIC OPERATIONS ON THE EXTERNAL EAR

The external ear when very large or very projecting may be operated on for cosmetic reasons.

Macrotia.—The pinna is uniformly enlarged but does not project outwards unnaturally. Make the incision AB (Fig. 57) through the whole thick-

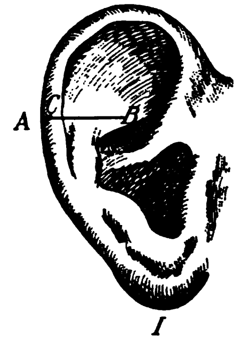


FIG. 57.

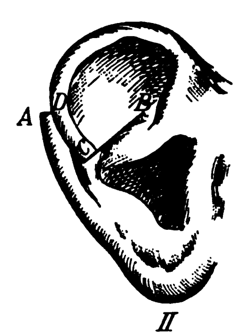


FIG. 58.

ness of the pinna. Pull the upper segment of pinna over the lower segment to see how much tissue must be removed in order to correct the deformity (Fig. 58). Make a cut from D to B and remove the overlapping triangle

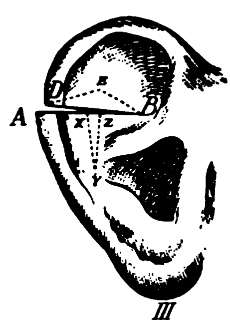


FIG. 59.

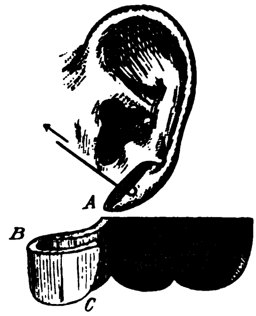


FIG. 60.

of tissue DBC. The edge of the pinna at D does not correspond with the edge of the pinna at A, therefore cut away a wedge-shaped segment of pinna DEB (Fig. 59) and so permit the point D to be brought out to the point A. With sutures introduced alternately from the outer and inner side of the ear,

unite the edge DEB to the edge AB. Instead of lengthening the wound edge DB, it might be possible to shorten the edge AB by cutting out the wedge of tissue XYZ (Fig. 59).

(A) **Plastic Restoration of Lobule.**—The lobule of the ear may be absent congenitally or may have been removed by accident or for disease. If removed for disease it may be replaced at the primary operation or later.

Gavello's Operation.—*Step* 1.—Freshen the stump of the lobule. Apply pressure with a hot pad to stop bleeding. Retract the stump upwards.

Step 2.—Reflect, and fold on itself the flap ABC (Fig. 60). With sutures keep the two raw surfaces of the flap together.

The flap or new lobule must be one-third larger than the normal lobule; this to allow for shrinkage.

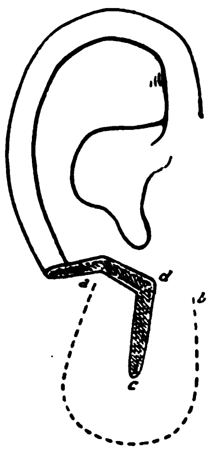


FIG. 61.—(*Laurens.*)

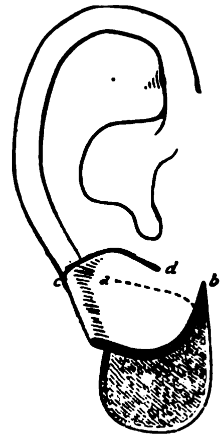


FIG. 62.—(*Laurens.*)

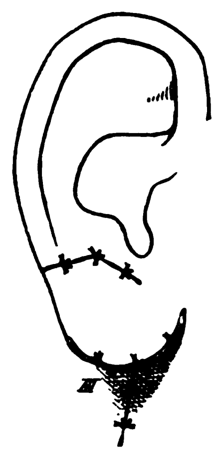


FIG. 63.—(*Laurens.*)

Step 3.—Suture the upper edge of the new lobule to the vivified stump of the old lobule.

Step 4.—Close the wound in the neck either by sliding of skin or by grafts.

(B) **Coloboma of Lobule.**—A part of the lobule may be absent either congenitally or as the result of accident, usually the result of necrosis following piercing of the lobule with dirty instruments. Nelaton's method of operating will be easily understood by glancing at Figs. 61, 62, 63.

SYNECHIA OF LOBULE

Occasionally, instead of hanging in the normal fashion the lobule is adherent to the body through its whole length. The deformity may be annoying. The following method is suggested for correction of the synechia: Mark the line along which the lobule ought to be separated. In front of the ear raise the flap X (Fig. 64), having its base corresponding to the above-mentioned line and attached to the ear. Behind the ear elevate the flap Y, having its

base or pedicle attached to the neck (Fig. 65). Divide the lobule along the line AB. Attend to hemostasis. With the flap X cover the wound now existing on the new inner edge of the lobule. With the flap Y cover the corresponding wound in the neck. Fix the flaps in position with sutures.

FIG. 64.

FIG. 65.

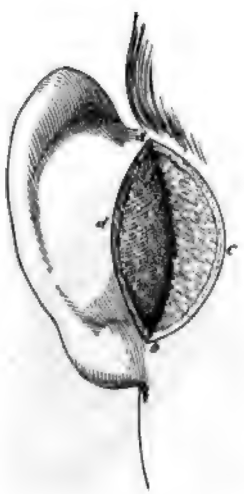


FIG. 66.—(*Laurens.*)

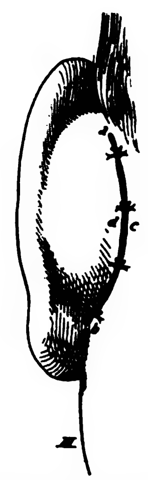


FIG. 67.—(*Laurens.*)

PROMINENT EARS

Instead of lying parallel to the head the auricles may stand out more or less at right angles to the head. The deformity, especially when the ears are large, is considerable and may have an injurious influence on the patient's career. There are several methods of correcting the deformity.

Method A.—The deformity is not of high degree. There is little or no macrotia, there may be, as in Bacon's case, some microtia. Remove the whole

thickness of the skin from the area *abcd* (Fig. 66). Take away more skin from the auricle than from the mastoid region. Suture the edge adb to the edge *acb* (Fig. 67).

Fig. 68.—(*Payr.*)

Fig. 69.—(*Payr.*)

Fig. 70.—(*Payr.*)

Fig. 71.—(*Payr.*)

Method B.—A portion of the skin and an ellipse of cartilage may be removed (Fig. 68), and the wound closed (Fig. 69). The result is, however, not satis-

FIG. 72.—(*Payr.*)

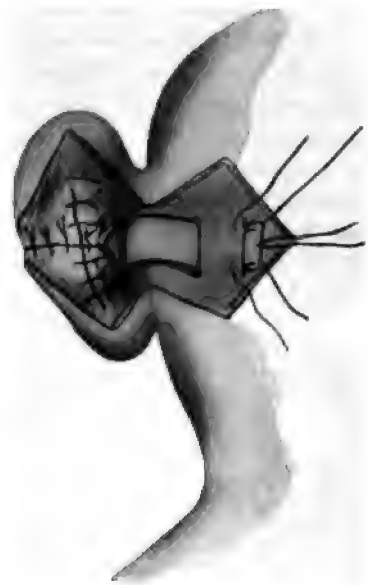


FIG. 73.—(*Payr.*)

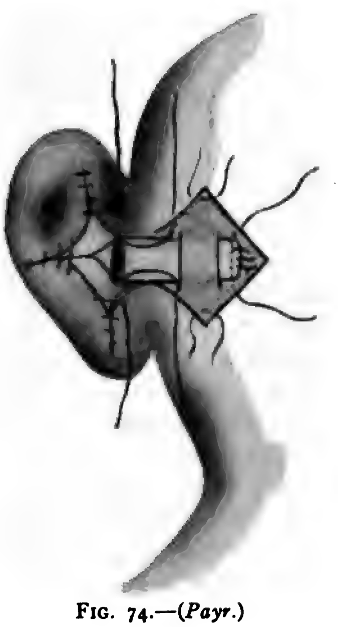


FIG. 74.—(*Payr.*)

factory. Payr recommends the excision of a sickle-shaped portion of cartilage (Fig. 70). This gives better results.

Method C (Payr's Operation).—Payr found ("Archiv für klin. Chir.," lxxviii, 918) that the results from Method A were good at first but that the spring-like action of the cartilage of the ear caused stretching of the scar and some recurrence of the deformity. In cases of great deformity he operates as follows:

Step 1.—Remove the skin from the areas I and II (Fig. 71). Make the incisions *a–a*, *b–b*, *c–c*, down to, but not into, the cartilage. Reflect the flaps aabb and aacc.

Step 2.—From the most prominent part of the concha posteriorly make two parallel incisions about ⅜ inch apart, through the cartilage out to the free margin of the auricle. Do *not* injure the skin covering the anterior surface of the cartilage. Elevate and turn back the flap of cartilage (Fig. 72). From the cartilage above and below the transverse wound remove sickle-shaped portions of cartilage (Fig. 72).

Step 3.—With sutures close the wounds in the cartilage (Fig. 73).

Step 4.—In a convenient location make two parallel incisions through the mastoid periosteum and elevate a bridge of periosteum. Pull the flap of cartilage under the periosteal bridge and suture it there (Figs. 73 and 74).

Step 5.—Close the wounds aa, bb, cc with sutures (Figs. 71 and 74). Unite the edges of the denuded area I to the edges of the denuded area II (Figs. 71 and 74). This operation corrects both the macrotia and the malposition. If the ear is not much enlarged and there is marked malposition the anchoring flap of cartilage may be made narrow and the sickle-shaped resection of cartilage may be omitted.

FIG. 75.—1. Helix. 2. Antihelix. 3. Fossa of helix. 4. Fossa of antihelix.

Method D.—Luckett ("Surg., Gyn., Obst.," June, 1910) considers that in prominent ears the deformity is due to absence or insufficient development of the antihelix (Fig. 75), the cavity of the concha being continuous with that of the helix. To form an antihelix Luckett operates as follows:

Step 1.—On the inner or posterior surface of the auricle make a crescentic incision through the integument opposite the line of the intended new antihelix. Remove the inscribed integument. Dissect the edges of the skin free from the cartilage and retract them. Remove a similar crescentic segment from the cartilage. The amount of cartilage removed depends on the extent of the deformity. Do *not* buttonhole the skin on the anterior or external side of the ear when removing the cartilage.

Step 2.—Close the wound in the cartilage by Lembert sutures so as to invert the edges (Fig. 76) and form an antihelix.

Step 3.—Close the skin wound with horse-hair sutures.

Hematoma Auris. Othematoma. Cauliflower Ear.—Don H. Palmer (Northwest Med., Dec., 1913) operates with good results in this deformity as follows: Sterilize the external ear and surroundings by any good method without iodin. Plug the external auditory meatus with cotton. Make an incision over the most prominent part of the swelling into the hemorrhagic cavity. With curette or fine gouge remove all clots, new-formed cartilage or bone. Gently scrape the anterior surface of the old cartilage until it is smooth. Close the incision except for a small opening which will just admit a Eustachian catheter connected with a small Pynchon pump. With the pump remove all accumulated blood; the suction compels approximation of the skin,

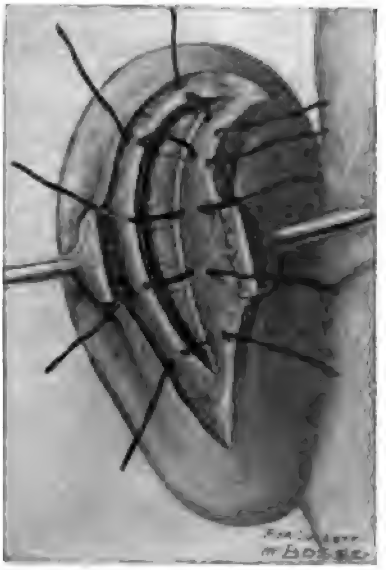


FIG. 76.—(*Luckett, Surg., Gyn. Obstet.*)

perichondrium and cartilage. Dry the skin. Put a fresh, dry plug of non-absorbent cotton in the external auditory canal. Apply sterile vaseline generously to both surfaces of the ear and to the surrounding parts. Place a cardboard mould around the ear and fill it with plaster-of-Paris cream so that the ear is completely encased in the plaster through which the Eustachian catheter projects with the connected pump working continuously.

As the plaster hardens rotate the catheter sufficiently to permit its easy removal. As soon as hardening is complete remove the catheter; the track left by its removal, permits drainage. Hold the plaster cast in place by bandages. After about ten days remove the cast by fragmentation.

CHAPTER VI

EMPYEMA OF THE ANTRUM OF HIGHMORE

INTRANASAL OPERATION

Cocainize the lower meatus of the nose. Seat the patient with his head well thrown back. Introduce a stout, curved trocar and cannula through the nostril to a point immediately under the inferior turbinated bone, *i.e.*, to a point in the highest portion of the inferior meatus of the nose. Before this can be done it may be necessary to remove part of the inferior turbinate bone. Turn the trocar so that its point touches the outer wall of the nose (inner wall of the antrum) at right angles. Push, with steady force, outwards so as to make the trocar enter the antrum. Wash out the antrum with warm water or a mild antiseptic. Do *not* use peroxide of hydrogen; it may spread infection. Remove the trocar. No dressings are required. The trocar used ought to be large enough to leave a more or less permanent opening.

Alveolar Route.—Provide a drill about the size of a No. 16 French sound. Provide one or more metal drainage tubes about ¾ to 1 inch long, provided with a flange to prevent their slipping into the antrum. Provide a nozzle which can slip into the drain and permit of irrigation.

Examine the teeth. If a carious tooth is found it is probably the cause of the empyema, and must be extracted. (The teeth at fault may be the first premolar or the first or second molars.) Through the tooth socket drill a hole upwards and backwards (never inwards) into the antrum. Remove the drill, substituting a drainage tube. Irrigate daily through the tube.

Never sacrifice a healthy tooth to gain access to the antrum by this route. The drainage tube used ought to fit the drill hole snugly and so have no tendency to fall out.

Radical Operation.—This method is based on the obsolete method of drainage through the canine fossa. Administer a general anesthetic.

Step 1.—Retract the upper lip upwards and outwards. Make an incision to the bone from the maxillary tuberosity to a point immediately below the nares, high up above the line of the reflection of the mucosa from the alveolus to the cheek. Attend to hemostasis by temporary pressure. Pull the upper edge of the wound upwards with a retractor.

Step 2.—With a periosteal elevator expose the whole outer wall of the antrum. Do not injure the infraorbital nerve. Open the antrum with a chisel, enlarge the opening with rongeur forceps. Cleanse out any pus and blood which may be present. Attend to hemostasis by temporary packing with gauze.

Step 3.—Explore the antrum. If the disease is catarrhal merely wash the cavity. If granulation tissue is present in quantity remove it by scraping

away with pledgets of gauze or with a curette used gently. If necrosed bone is present remove sequestra and diseased bone. Occasionally sinuses leading through the alveolus to the mouth require excision (Laurens) through a vertical cut reaching from the primary incision to the alveolar margin. Examine the inner wall of the sinus carefully behind the normal opening into the nares, because ethmoidal disease may cause necrosis here, and unless the ethmoid trouble is treated a cure may be prevented.

Step 4.—Provide permanent drainage for the sinus as follows:

With chisel, forceps, etc., remove the lower 2/3 of the nasal wall of the sinus. This means removing the lower turbinate bone as well. Bleeding will be free but is easily stopped by gauze pressure. Be sure that no crest of bone remains between the nasal and antral floors (Laurens). Pack the cavity with gauze brought out through the nostril.

Step 5.—Close the wound in the mouth with sutures.

Remove the pack in twenty-four or forty-eight hours. After this keep the parts as clean as possible without greatly disturbing the patient.

P. L. Friedrich's Radical Operation.—Make an incision down to the bone, skirting the ala of the nose in the natural groove of this region. Expose the outer and lower angle of the pyriform opening. With the elevator separate the soft parts and periosteum together from the outer surface of the superior maxilla; it may be necessary to make an incision to the bone from the middle of the primary incision downwards and outwards for about three-fourths of an inch. With the elevator separate the muco-periosteum of the outer wall of the nose from the edge of the pyriform opening backwards for about one inch. A fair area of both the facial and nasal walls of the lowest portion of the antrum are exposed by the above means. With chisel and rongeurs, beginning at the lower and outer angle of the pyriform opening, cut away the bony walls (both facial and nasal) of the antrum. In doing this, part of the inferior turbinate bone is removed.

Friedrich's operation gives very free access to the antrum and permits proper treatment both of the antrum and of any fistulæ leading from it.

The intranasal and alveolar methods of treating empyema of the antrum are suitable in cases of catarrhal inflammation, or where dental disease is the primary cause of the trouble. When the disease resists drainage for two or three weeks the probabilities are that osteitis, necrosis or some granulomatous condition is present and only the radical operation will avail.

CHAPTER VII

OSTEOPLASTIC EXPOSURE OF THE ORBIT

Frankes' Modification of Kronlein's Operation.—This operation is of value in the exploration of, and removal of tumors from, the orbit when it seems possible to preserve the eye.

Step 1.—Below the level of the eyebrow make an incision corresponding to the external half of the upper margin of the orbit. Continue the incision downwards along the outer margin of the orbit to a point near the lower orbital margin. From this point cut backwards on the malar to the middle third of the zygoma.

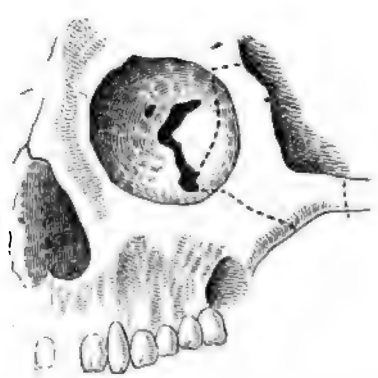


FIG. 77.—Osteoplastic exposure of the orbit.

Step 2.—(*a*) Subperiosteally divide the zygoma near its middle. (*b*) Beginning at the upper and outer part of the orbital rim, subperiosteally divide the outer orbital rim backwards and downwards to the inferior orbital fissure (Fig. 77). This is best done with a chisel. (*c*) Beginning at the lower and outer part of the orbital rim, subperiosteally divide the malar backwards to the inferior orbital fissure and to the origin of the masseter.

Step 3.—Reflect the bone flap thus formed. Remove any portions of the external orbital plate which obstruct, and so expose the orbital fat.

Step 4.—Do whatever may be necessary to the orbital contents.

Step 5.—Replace the bone flap. Suture the skin. Suture of the bone is unnecessary.

CHAPTER VIII

EXCISION OF UPPER JAW

Resection of the Alveolus, Schlange's Method.—This is usually called for because of tumors. Small tumors may be removed by the methods recommended in excision of the alveolus of the lower jaw. When much of the alveolus is involved and perhaps part of the palate, Schlange operates as follows: Provide three or four gouges with blades 1 to 2 inches wide. Tampon the nostril on the affected side. If necessary in order to obtain free access, split the cheek by a curved incision running upwards and outwards from the angle of the mouth. Open the jaws widely with a gag. Retract the cheek and upper lip thoroughly. Beginning posteriorly and as remote as possible from the disease drive the gouges one after the other vertically upwards through the alveolar and palatal processes into the antrum. Leave each gouge undisturbed *in situ;* this is of great importance because removal of the instrument would at once be followed by serious bleeding. "When the horizontal portion of the superior maxilla has been thus divided by three gouges the part to be removed is held in place merely by the anterior wall of the antrum. With the fourth gouge quickly divide this connection and exerting slight leverage on the chisels remove them and the separated bone together. Before the gaping wound has time to bleed pack it with a tampon or large sponge which has been held in readiness. The operation can be carried out in a few minutes and with almost no loss of blood." When much of the alveolus is removed from a young and growing patient great deformity of the jaw and teeth may be expected unless the defect is properly filled by a suitable prosthesis.

Many incisions have been devised to expose the superior maxilla. Probably the best are those of Weber (A, B, C, D, Fig. 78, and Velpeau (V. P, Fig. 78).

Weber's Incision.—Beginning immediately below the inner angle of the eye, make the incision B, C, D, which skirts the ala of the nose and divides the upper lip in the middle line. From the point B (Fig. 78) make the curved incision (B, A, Fig. 78) which follows the lower margin of the orbit. Reflect outwards the flap outlined by the complete incision.

Velpeau's Incision.—This incision is very similar to that of Syme. Beginning at the angle of the mouth, make the incision P. V (Fig. 78) through the [illegible] of the cheek. The cut runs obliquely upwards and outwards [illegible] the angle of the mouth for such a distance as will permit of [illegible] the maxilla by reflection of the cheek upwards and inwards. [illegible] as good as Weber's.

[illegible] the [illegible] covering the floor of the [illegible] and [illegible] the orbit [illegible] upwards with a flat [illegible]

forceps or Gigli saw divide the malar bone and with it part of the orbital floor at the point V (Fig. 79). In the same manner divide the nasal and orbital processes of the superior maxilla at the point X. Open the patient's mouth and with a knife make an incision through the muco-periosteum of the hard palate, parallel and close to the middle line. Continue this incision forwards and then upwards through the muco-periosteum covering the alveolus to the nasal aperture. With bone forceps, Gigli or finger saw divide the hard palate and alveolus along the line of the muco-periosteal incision. With knife, or better with scissors, separate the soft palate from the hard palate on the side being excised. Seize the superior maxilla with lion-jawed forceps and forcibly remove it with a twisting motion. Any undivided strands of tissue may be severed with scissors. The internal maxillary artery will generally be found bleeding vigorously in the depth of the wound. It should be seized with forceps and ligated. Oozing is stopped by pressure with gauze pads wrung out of very hot water. Pack the wound with iodoform gauze. Replace the flap of soft structures over the packing and suture it in position.

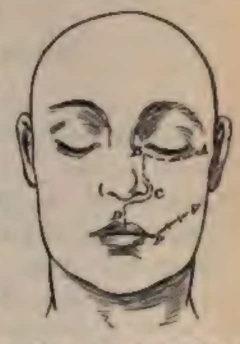


FIG. 78.—A, B, C, D, Wezer's incision; P, V, Velpeau's incision.

The after-treatment consists in having the patient lie on the side operated upon or sit up in bed or a chair as early as possible. This is to avoid danger of pneumonia. The mouth must be kept clean. Closure of the wound usually takes place rapidly. When recovery has taken place, consult a good dentist with regard to the use of an artificial palate.

FIG. 79.—Excision of upper jaw. X, Y, Z. Usual lines for division of bone. P, Q. Section may be made here instead of at Z, when disease is extensive.

Keen notes that sarcoma of the upper jaw often extends through the infundibulum into the frontal sinus. This extension must be looked for and removed. Extend the incision C, B (Fig. 78) upwards to the nasal side of the inner canthus over the frontal sinus. Remove with a small rongeur the anterior wall of the infundibulum and of the frontal sinus; wipe away the tongue-shaped process of the sarcoma with a gauze pad.

W. J. Hearn, Matas, and others always ligate the external carotid before excising the jaw. The former surgeon finds in doing so that he always exposes some enlarged glands which require removal. Matas emphasizes the importance of ligating the external carotid high up, well above the bifurcation, otherwise there is danger from cerebral embolism.

A. H. Ferguson's operation, suitable in cases where the skin is not involved.

1. Place the patient with head hanging over a sand-bag.

2. Make an incision about one-half inch long over the nasal process of the superior maxilla; through this, with an osteotome, divide the bony process.

3. Repeat Step 2 over the junction of the superior maxilla and the malar and divide the bone.

4. Cut through the alveolar process and the hard palate. Save as much of the soft palate as possible.

5. With elevator or forceps evulse the jaw and pull it out through the mouth. Pack the cavity with iodoform gauze.

BARDENHEUER'S OPERATION FOR PARTIAL EXCISION OF THE UPPER JAW AND IMMEDIATE PLASTIC REPAIR

By means of the incision A, B, C (Fig. 80) the flap C, E, D is reflected and the jaw and tumor exposed. By means of saw, bone forceps, and scissors

Fig. 80.—After Bardenheuer.

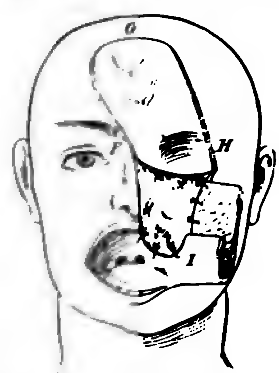


Fig. 81.—After Bardenheuer.

[illegible] is partially excised, the object being to remove the tumor and with [illegible] margin of healthy bone. Bleeding is arrested by ligature, hot water [illegible] gauze pressure. The incision F, G, H (Fig. 81) outlines a skin-flap [illegible] in the pedicle of which is a portion of the skin of the upper eyelid [illegible] the whole eyebrow. The flap is turned, epidermis inwards, into [illegible] F, I, H and there sutured. The flap C, E, D is now turned back [illegible] old position and there sutured. Most of the wound F, G, H is covered [illegible] grafts. After the lapse of two weeks the pedicle of the flap [illegible] divided and the eyelid and eyebrow contained in it returned to their [illegible] position. The wound left where the pedicle was divided must be [illegible] and closed. The result is seen in Fig. 82.

[illegible] OF SUPERIOR MAXILLA WHERE THERE IS TUMOR INVOLVING BOTH THE BONE AND THE SKIN

[illegible] A, B, C (Fig. 83). [illegible] D, F, E, which joins [illegible]

and E. Reflect the flap A, D, E, C towards the opposite side of the body (Fig. 84). Reflect the skin at B towards the ear so as to expose the zygoma and the frontal process of the malar. Divide the bones as shown in the dotted lines in Fig. 84. Remove the tumor and superior maxilla as in the classical

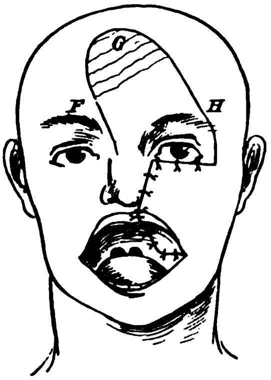


FIG. 82.—(*After Bardenheuer.*)

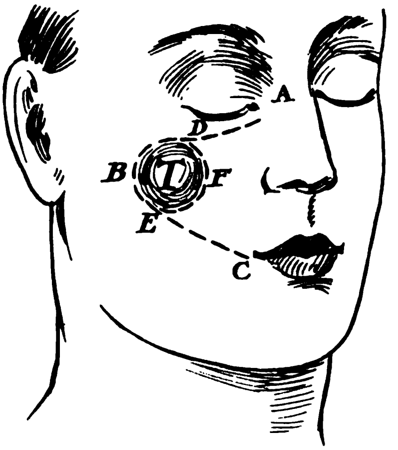


FIG. 83.—Author's method of excising upper jaw for disease involving the skin.

operation for excision of the upper jaw. Pack the wound with iodoform gauze. Replace the flaps and suture them in position.

EXTENSIVE EXCISION OF UPPER JAW

The younger König in very extensive disease of the upper jaw necessitating removal of the floor and outer wall of the orbit recommends the following operation:

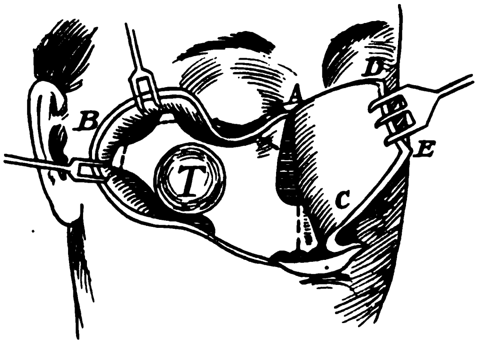


FIG. 84.—Author's method of excising upper jaw for disease involving the skin.

1. Ligate the external carotid between the origin of the superior thyroid and lingual arteries. This step is simple, harmless, and very useful.

2. Expose the bone by Velpeau's incision. Remove the disease.

Recognize and expose the temporal muscle in the outer part of the l. At the level of the coronoid process and about 1½ finger-breadths its anterior margin split the muscle upwards and downwards. With el divide the ascending ramus of the lower jaw along the line in which uscle was split. The result of the above is to provide a flap, consisting of ral muscle and bone, attached above to the skull and free below (Fig. 85).

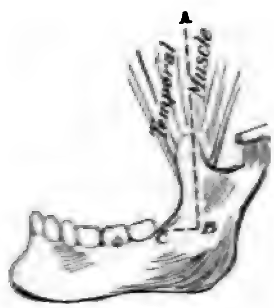
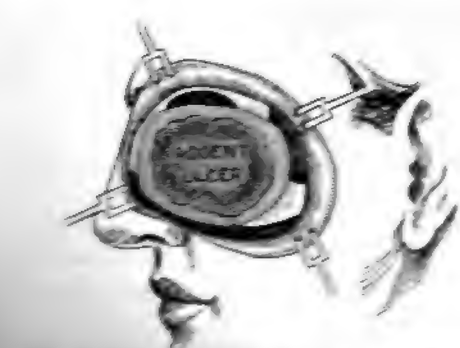


Fig. 85.—F. König's operation.

Fig. 86.—Author's method of excising rodent ulcer.

Turn this flap inwards and unite its free extremity to the remains of the al process, so that a firm floor is provided for the orbit and the eye is kept place.

Complete the operation by closure of the skin-wound and packing with gauze.



it from the bones so as to lay bare to touch the upper margin of the orbit, the external angular process of the frontal bone, the temporal process of the malar (Fig. 87), the external anterior surface of the superior maxilla above the alveolar process, and the nasal bone on the affected side. As hemorrhage occurs, it must be arrested *at once*.

3. With bone forceps or chisel cut through the bones as shown in Fig. 88. Bone incision A (Fig. 88) penetrates the antrum of Highmore.

4. Separate the orbital contents from the roof of the orbit and divide the optic nerve.

It is now easy to remove the disease surrounded by a fairly large zone of healthy tissue. The cavity is packed with iodoform gauze. After the lapse

Fig. 88.—Excision rodent ulcer.

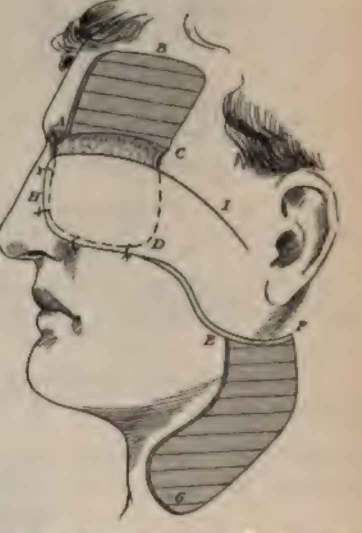


Fig. 89.—Plastic repair after excision rodent ulcer.

of about ten days endeavors may be made to lessen the deformity which has been produced. As the cavity is largely lined by mucous membrane, it is proper that an endeavor should be made to provide its new covering with an epidermal surface internally.

Type of Operation to Repair the Deformity.—On the *hairless* forehead make the incision A, B, C, Fig. 89, so as to obtain a flap, A, C, D, of size and shape suitable to provide an epidermal outer and anterior wall to the cavity left by operation. The base (A, C) of the flap is a little above the orbit and ought to extend beyond the orbit on one side or the other so as to have plenty of nourishment. The flap is now turned down so that its epidermal surface faces inwards, its raw surface outwards. The edges of the flap are stitched with catgut in the position A, C, D (Fig. 89). From the neck the flap E, F, G is dissected up and sutured in the position F, E, H, I. The raw surfaces A, B, C and E, F, G

are lessened in size by sliding their edges centripetally and there suturing them. Any parts not covered by skin are now grafted by Thiersch's method.

After the lapse of two weeks, if everything has gone well, the pedicles of the flaps A, D, C and H, I, E are divided and their remnants turned back into their old positions. A certain amount of trimming and suturing must be done at the margins of the now repaired deformity.

Note.—In the original operation when the bone incisions are being made it is wise to divide the nasal bones last, so as to avoid the entrance of blood into the nose. The complete dissection of the soft parts before attacking the bones ensures that most of the bleeding will have been attended to before any of the facial cavities have been opened. Should the patient's strength warrant, the reparative work might be done at the same sitting, but the disease generally affects the old and debilitated.

Osteoplastic Resection of Upper Jaw (Kocher).—Suitable for the removal of nasopharyngeal and retropharyngeal neoplasms—*e.g.*, sarcomata, etc.

Preliminary ligation of both external carotid arteries may or may not be practised. Place the patient in Trendelenburg's position. This renders preliminary tracheotomy unnecessary.

Step 1.—Split the upper lip near the middle line from nostril to mouth. On each side divide the buccal mucosa at its line of reflection from cheek to alveolus. Only divide the mucosa sufficiently to permit the performance of Step 2.

Step 2.—With a chisel divide the anterior-external wall of the antrum from the nose outwards and backwards above the alveolus. This opens the antrum.

Step 3.—With a wide chisel (better osteotome) of thin steel divide the alveolus and hard palate close to the middle line. With strong sharp hooks pull the halves of the upper jaw apart, pushing the vomer to one side and dividing any nasal mucosa which hinders. If necessary divide the soft palate. Remove any of the turbinated bones which obstruct.

Step 4.—Free access to the base of the skull is now possible. Remove the tumor *secundum artem*, using the cautery if necessary.

Step 5.—Replace the halves of the jaw and fix them by a suture (wire or silk) penetrating the alveolus. Suture the soft palate if it has been divided.

Step 6.—Apply iodoform gauze packs to the bed from which the tumor was removed bringing the ends of the pack out through the nose.

Partsch's Method.—(Beiträge z. klin. Chir., xci, 555).—Place the patient on a table which is slightly inclined to one side and has its lower end moderately elevated. The patient's neck is supported on the edge of the table (not hanging as in Rose's position). A general anesthetic is administered through a tube. The external carotid arteries may be ligated or hemorrhage may be lessened locally by the use of adrenalin.

Make an incision above the alveolus of the upper jaw from the second molar of one side to the second molar on the other side. Retract the soft parts upwards and open the nasal fossæ by freeing the mucosa at their anterior orifices. With a thin chisel divide the septum nasi along the floor of the nose. Divide the anterior and external walls of the antrum of Highmore at the level of the

antral floor. Do this on both sides as far back as the maxillary tubercles. The alveolus and the palatal vault can now be pushed down as a flap the hinge of which corresponds to a transverse line passing through the posterior extremities of the maxillary body. This gives very free access to the nasopharynx without interfering with the palatine arteries. When the operation is finished the flap is easily replaced and secured by some stitches through the mucosa.

Reinhardt ("Zentralblatt für Chir.," May 9, 1908) has collected fourteen cases in which this operation has been performed without a death.

Exposure of the Base of Skull by Temporary Resection of the Palate.—C. Hofmann's method ("Zentralblatt für Chir.," 1910, No. 24).

Step 1.—Make an incision through the mucosa of the palate from the premolar tooth on the right side to a corresponding point on the left side. Nearly at right angles to the above incision make a cut immediately to the inner side of the alveolus (on the right or left side of the palate, according to the location of the tumor in the nasopharynx). This incision extends backwards to the edge of the soft palate dividing the muco-periosteum covering the hard palate and the whole thickness of the soft palate.

Step 2.—With a chisel divide the bone of the palate corresponding to the incision made in Step 1. With an elevator raise the palate and reflect the flap of bone and soft parts, fracturing the bone in the pedicle of the flap. While this is being done the nasal septum must necessarily be either fractured or divided.

Step 3.—After removal of the tumor from the nasopharynx replace the flap and fix it with a few sutures. Hofmann states that the flap tends to stay in position and that the whole operation is easy.

CHAPTER IX

LOWER JAW—RESECTION

I. RESECTION OF THE ALVEOLAR PROCESS

Incise the muco-periosteum around the portion of bone to be excised. If the portion to be excised is small, its removal may be effected with rongeur forceps or with the chisel and mallet. In using the chisel the surgeon should hold the instrument in one hand, support the jaw with the other, and let his assistant manipulate the mallet. When the excision is to be more extensive, one may with a finger saw make a vertical incision through the alveolar process in front of, and another behind, the portion to be removed, and join the lower ends of the vertical incisions by a horizontal one cut with a chisel or a saw operated by a surgical engine.

II. PARTIAL RESECTION OF THE HORIZONTAL RAMUS

Make an incision through the skin down to the bone along the inferior edge of the jaw. Separate the soft parts from the inner and outer surfaces of the jaw. If the operation is done for necrosis, preserve the periosteum; if for tumor, sacrifice it. Divide the jaw by vertical incisions made with the Gigli wire or the finger saw, in front of and behind the disease. If teeth are present at the lines of vertical incision, they must be removed before the saw is applied. Remove the segment of bone between the vertical cuts. Whenever the nature and extent of the disease permit, it is important to leave the lower edge of the jaw *in situ* (X, Y, Fig. 90), as then the continuity of the maxilla is maintained. To accomplish this, the vertical bone incisions do not completely divide the jaw, and the excision is completed with the chisel. It is difficult to use a saw on the lower jaw. To cut accurately with a chisel is no easy task and the bone is very liable to fracture. A good method to secure precision and safety is as follows: After incising the muco-periosteum at a safe distance from the tumor, bore a series of holes about 1/4 inch apart all around the portion to be removed. When this has been done it is easy to complete the excision with rongeur forceps or chisel. If possible, suture the mucous membrane of the floor of the mouth to that of the cheek. Close the cutaneous wound after providing for drainage.

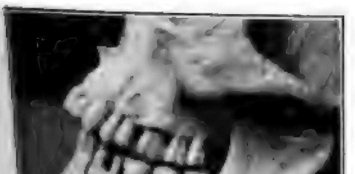


FIG. 90.

III. RESECTION OF ONE-HALF OF THE INFERIOR MAXILLA

Transfix the tongue with a stout thread for purposes of traction. Make a vertical incision in the middle line through the chin, beginning a little below the edge of the lower lip and ending on the lower edge of the jaw. Do not include the margin of the lower lip in the cut unless compelled to do so by the size of the tumor.

From the lower end of the vertical incision make a cut along the inferior edge of the jaw to its angle. If necessary, continue the cut up the posterior edge of the ascending ramus of the jaw to a point not less than one finger-breadth below the lobe of the ear. Before the facial artery is divided it should be ligated.

With periosteal elevators, scissors, and knife separate the soft parts from the outer side of the bone to be removed. If the operation is for the removal of a tumor, sacrifice the periosteum. Choose the line in which to divide the bone anteriorly, extract any teeth which may be in the way, and divide the bone with the Gigli wire or finger saw after the soft parts have been separated from both sides of the bone along the line of section. Pull the jaw downwards and outwards and separate the soft parts from its inner surface (mylohyoid, geniohyoid, and internal pterygoid muscles, submaxillary gland, etc.). Pull the jaw downwards, expose the coronoid process, and divide its attachments to the temporal muscle. It may save time and be easier to cut through the coronoid process with bone forceps than to separate the temporal muscle from it.

By blunt dissection separate the masseter muscle and the parotid gland from the ascending ramus. With a twisting movement directed downwards and outwards tear the head of the bone out of its bed and the active part of the operation is completed. Attend to hemostasis. If possible, suture the mucous membrane of the floor of the mouth to that of the cheek. Close the external wound after providing for drainage.

The after-treatment consists in endeavoring to keep the mouth clean by means of frequent washing with mild antiseptic solutions, in nourishing the patient, and in encouraging him to sit or walk about at as early a date as possible.

When, after any operation in which one-half of the inferior maxilla or a segment of it is removed, deformity results and the teeth of the lower jaw no longer articulate with their fellows above. Some surgeons or dental surgeons have managed by a long and painful process to push the fragments of the lower jaw back into their normal position after healing has taken place and have maintained the position by means of a plate or of bridge-work.

Sinclair White ("Brit. Med. Journ.," Nov. 27, 1909), in removing two inches of the lower jaw for a tumor preserved the periosteum of the lower edge of the excised segment. "The resected surfaces of the lower jaw were pierced with a drill to the depth of 3/4 inch. The drill hole in the body was horizontal and placed near its lower margin, so as to miss the teeth roots; that in the

ramus was vertical and somewhat posterior to the mandibular foramen. The ends of a suitable length of stout silver wire were jammed tightly into the drill holes, and the wire completely covered by suturing together the mucous membranes of the cheek and the floor of the mouth over it. The diagram (Fig. 91) indicates the position and curve of the wire.

A small drain tube was placed in the neck end of the wound and retained for forty-eight hours, and the mouth was rinsed frequently with hydrogen peroxide solution. A little pus formed in the track of the tube, but the wound in the mouth healed quite kindly.

"At the present time, except for the skin scar, there is absolutely no external deformity. He can open his mouth almost to the full, and when the jaws are closed the teeth on the right side meet accurately those in the corresponding side of the upper jaw. He is able to bite soft things, and has to be restrained from attempting greater masticatory feats."

Partsch,* after removing a segment of the lower jaw, keeps the ends of the bone in correct position by means of a perforated metal plate united to the bone by a couple of wire stitches. (See Fig. 92.) The metal plates are protected

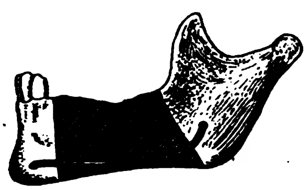


FIG. 91.—Metal splint used after resection lower jaw. (*Sinclair White.*)

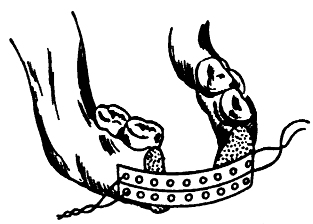


FIG. 92.—Metal splint used after resection lower jaw.

with rubber tubing, and the mucous membrane of the floor of the mouth and of the cheek are sutured together *below* the metal plate so that the latter lies exposed in the oral cavity. As soon as a proper dental apparatus or plate can be made and properly fitted, the temporary metal plates are removed. Berndt, in cases where half the inferior maxilla has been removed, replaces it with an apparatus of celluloid. After the bone has been removed he sutures the mucous membrane of the floor of the mouth to that of the cheek, packs the wound, and lays silkworm-gut cutaneous sutures in position but does *not* tie them. After the lapse of about ten days he takes a celluloid ring pessary, softens it by boiling, moulds it to the proper shape, and puts it into the wound so that one end is in the glenoid cavity while the other rests against the sawed surface of the remnant of the lower jaw. He next closes the skin-wound and ties the sutures already in place, thus completely covering the celluloid apparatus. Berndt reports that slight suppuration often takes place anteriorly from irritation to the sawed surface of bone, but that if a small portion of the celluloid is then cut away by forceps, a little fibrous tissue forms between the bone and the foreign body, and

*"Archiv f. klin. Chir.," lv, 746.

the wound heals. One patient* seven months after operation claimed to have celebrated Christmas by cracking nuts with his jaw, one-half of which was celluloid, and to have suffered no ill consequences.

By an incision made through the skin below the jaw Macewen has implanted a piece of rib between the fragments of jaw. Of course no communication existed between the site of implantation and the mouth. The implanted bone was obtained from a rib near the axilla. The result was perfect.

Macewen's method has been successfully carried out by a number of surgeons. Clarence McWilliams found that if the transplant was entirely deprived of periosteum it became absorbed. This does not agree with Macewen's observa-

FIG. 93. (*Stillman.*)

tions. Stanley Stillman ("Annals Surg.," July, 1912) uses Murphy's silver-wire girder (Fig. 93) to hold the remnants of the inferior maxilla in good position until healing has advanced far enough to permit bone implantation. He finds the silver cannot be left *in situ* permanently but that when it is removed the scar tissue keeps the bones in a useful position—so useful that the patient may prefer not to have the transplantation made.

H. Nimier† gives an admirable description of Martin's prosthetic apparatus suitable for use after even very extensive excision of the inferior maxilla. He says: Provided with a segment of maxilla formed out of hard rubber, moulded in advance to represent the bone to be excised, the surgeon cuts and fashions it so as to fit between the remaining portions of the bone and to re-

* "Archiv f. klin. Chir.," lvi, 210.
† "Traité de Chir." Delbet and Le Dentu, v, 793.

establish the exact shape of the inferior maxilla. Two small platinum plates at each end of the apparatus are attached to the bones by screws, and, acting as *fish-plates* between the bone and the substitute for bone, keep the latter in position. If much of the ascending ramus has been removed, the anterior portion of the apparatus is fixed to the remnants of the coronoid process, while that portion corresponding to the articulation is left unattached. To assure solidity in such cases it is necessary to attach the apparatus to the palate by a moulded plate. On the upper edge of the apparatus a band of hard rubber roughly simulates the teeth. It is necessary to disinfect the tissues in which the foreign body is implanted, and for this purpose the apparatus is perforated in various directions, so that irrigation is easy. Fig. 94 shows apparatus used after an almost complete excision of the lower jaw. The above description applies to the implantation of a temporary splint. When cicatrization is complete, a permanent one replaces it. The permanent apparatus is merely a more elaborate edition of the temporary. In cases of extensive excision the apparatus may be introduced in two parts, which are then united by fish-plates and screws.

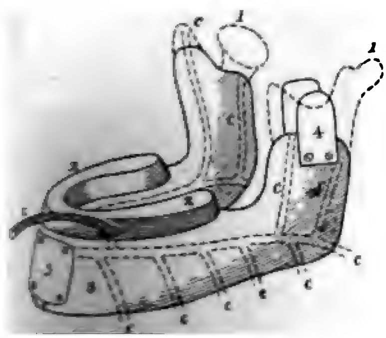


FIG. 94.

1. Articular process lower jaw. 2. Hard-rubber ridge representing teeth. 3. Artificial lower jaw. 4. Fish-plate uniting remnants of bone to the apparatus. 5. Fish-plate uniting the two halves of the apparatus. c. system of passages for irrigation.

Such extremely ingenious and complicated prosthetic devices will rarely be available when required, and if available, must rarely be serviceable. The tissues do not tolerate foreign bodies well for any length of time, and especially mobile bodies, such as described above. They have been described here more as examples of surgical ingenuity than as practical aids.

Undeveloped Lower Jaw.—When there is a marked want of development of the lower jaw there is not only present a disfiguring recession of the chin but the patient may be unable to open the mouth more than one-eighth of an inch. V. P. Blair ("Journ. A. M. A.," July 17, 1909), has twice successfully operated as follows:

Step 1.—Make an incision about ½ inch in length in front of the lobe of each ear and retract the parotid backwards.

Step 2.—Pass a curved needle with thread through the incision, under the ramus and out through the cheek. By means of the thread pull a Gigli saw round the ramus and divide the bone horizontally.

Step 3.—Forcibly stretch the muscles of mastication.

Step 4.—Pull the body of the jaw forwards if possible until the lower incisors are in front of the upper. Wire teeth of the lower jaw to teeth of the upper until sufficient fixation is obtained.

Prognathism.—The lower jaw extends forwards beyond the upper so that proper articulation of the upper and lower teeth is impossible. In adolescents

orthodontic appliances are capable of greatly improving or curing the deformity; in adults the aid of operative measures becomes necessary for a cure. The surgeon must always have the aid of a good dentist or orthodontist.

Harsha and Eisenstaedt's Method (Surg., Gyn., Obst., July, 1912).—Have plaster-of-Paris models of both upper and lower jaws prepared, also skia-

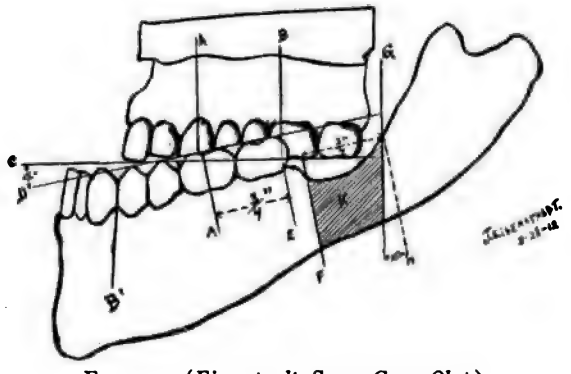


FIG. 95.—(*Eisenstaedt. Surg., Gyn., Obst.*)

graphs. Make careful measurements to ascertain the shape, size and location of the wedge of bone which it is necessary to excise on each side of the lower jaw to permit proper articulation with the upper jaw. If it is necessary to extract any teeth do so long enough before operation to permit of healing and to render submucous resection possible.

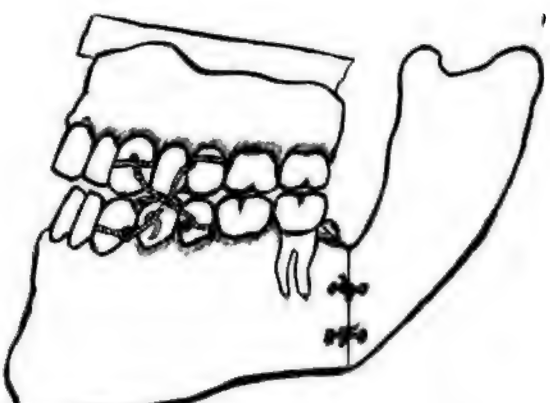


FIG. 96.—(*Eisenstaedt, Surg., Gyn., Obst.*)

Cardboard models of the lower jaw should be made on which to carry out experimental operations, as it is desirable to alter the angle of the jaw as well as to shorten the horizontal ramus. Make an incision about 2½ inches long beneath the border of the jaw. Through this separate the periosteum and mucoperiosteum from the bone completely around the segment of bone it is desired

to remove. Do this, if possible, without entering the mouth. With forceps and saw cut out the desired segment of bone. Unite the bone wound with wire sutures or Lane's plates. Close the skin wound, if necessary providing drainage. Carry out a similar operation on the opposite side. If necessary reinforce the union of the bone by interdental splints and wiring the teeth of the lower to hose of the upper jaw. (Figs. 95 and 96.)

ANCHYLOSIS OF TEMPORO-MAXILLARY JOINT

The usual procedure for the operative treatment of bony anchylosis of the temporo-maxillary joint consists in mere excision of the condyle of the lower jaw. Helferich, having had poor results from the above operation, modified it slightly. His modification is founded on the fact that interposition of the muscle between the fragments is a common cause of non-union in fractures.

Helferich's Operation.—Make a vertical incision 1½ to 2 inches in length, one finger-breadth in front of the ear. Ligate the temporal artery. Push the parotid gland aside; expose the condyle and neck of the lower jaw. The temporo-maxillary joint may be indistinguishable because of anchylosis. With a chisel divide the neck of the bone at a point about ½ inch below the site of the joint. Do not preserve the periosteum. Excise the condyle and neck of :he jaw above the point of section, taking away the periosteum with them. If nly one joint is anchylosed, the mouth can now be easily opened. If necessary, nlarge the skin-incision upwards. Reflect a long flap from the temporal mus-le, about one inch wide and with its base below. Turn the flap downwards that its free end can be tucked into the defect left by the excision of the ndyle. To turn the flap down and put it in position requires that a portion the zygomatic arch be removed. This is easily done with rongeur or bone rceps. Fix the muscular flap in position by a few sutures of catgut. Close e wound without drainage. Apply dressings. The result obtained from lferich's operation was most happy. Murphy's experience seems to show it a flap of fat is preferable to muscle in the above operation.

J. B. Murphy's Operation (Journ. A. M. A., June 6, 1914).—This operation l be best comprehended by a study of the accompanying figures. Figure 97 ws the L-shaped incision which gives good exposure but avoids injury to the ial nerve. The internal maxillary artery is shown passing inward behind d close to the neck of the mandible where it is liable to injury unless well tected during the operation. Figure 98 shows the neck of the bone exposed d being divided with a Gigli saw while the internal maxillary artery is pro-ted by means of two curved periosteal elevators.

In Fig. 99 the neck of the bone has been divided, the cut ends of the bone have en separated by traction during which time the protecting curved elevators re kept *in situ*. A flap of fat and fascia is dissected from the temporal ion and is turned downwards and inwards between the divided ends of mandible where it is securely anchored by tacking stitches.

The after-treatment consists in keeping the mouth open by means of a oden block until healing is complete.

How to know which side is anchylosed is important. Murphy's rules for this are:

1. There is flattening of the jaw on the *unaffected* side, most pronounced near the tip of the chin.

FIG. 97.—L-shaped skin incision above the zygoma and in front of the ear, so placed to avoid injury to the facial nerve. Note the relation of the external carotid, the temporal, and internal maxillary arteries to the field of operation. The last-named vessel in passing inward behind the neck of the mandible lies close to the bone and must be carefully protected from injury during the operation, especially at the time when the neck of the mandible is divided. (*Murphy.*)

2. When the patient attempts to open his mouth, the teeth move from $\frac{1}{60}$ to $\frac{1}{100}$ inch downwards and deviate a little in the direction of the anchylosed side, because of a slight sliding forwards of the mandibular articulation on the

unaffected side as the muscles of the neck are put on tension in the effort made to open the mouth.

3. A sliding motion on the unaffected side can be felt by the palpating fingers,

FIG. 98.—Dividing the neck of the mandible with the Gigli saw. (In actual operation the saw is not allowed to make so acute an angle as shown in the illustration, because of its great tendency to break when sharply bent.) (*Murphy.*)

and the muscular activity on that side is very much greater on attempted opening of the mouth than on the anchylosed side.

4. The muscles on the anchylosed side are more atrophied than those on the unaffected side.

L. W. Arlow* finds that in severe cases of temporo-maxillary anchylosis

* Ref. "Centralblatt f. Chir., 1903, No. 28.

the pathological changes are by no means limited to the joint, but that osteitis alters the form, size, and relations of the articular process, the coronoid process, the incisura semilunaris, the zygoma, etc. As a consequence simple division of the articular process is insufficient to give motion, and even when combined with osteotomy of the coronoid it often fails and resection of a part of the full

FIG. 99.—The pedicled fascia and fat flap is dissected out from the temporal fascia, and the free end of the flap is turned inward between the divided ends of the mandible and sutured securely in place with tacking stitches. (*Murphy.*)

width of the upper portion of the ascending ramus becomes necessary. Facial paralysis is more common as a result of tearing and distraction than of accidental division with knife or chisel. Recurrence is avoided by extensive removal of bone, by the implantation between the fragments of muscle or even of metal plates, and by early passive and active motion. Monod and Vanverts strongly recommend osteotomy of the ascending ramus as being easier than resection

of the neck of the bone, as efficient, and not liable to cause injury to the facial nerve. Rochet's method of operating is as follows:

Step 1.—Make an incision bordering the angle of the jaw. About one inch of this incision runs along the lower edge of the horizontal ramus, and about one inch along the posterior edge of the ascending ramus. Through this expose the inferior insertion of the masseter and detach it from below upwards with an elevator. This exposes the outer surface of the bone. In the same way expose the inner surface of the bone by separating the insertion of the internal pterygoid.

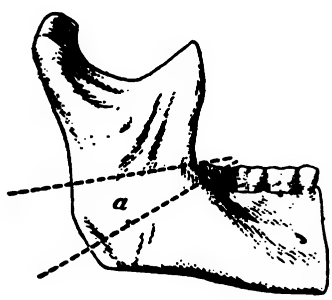


FIG. 100.

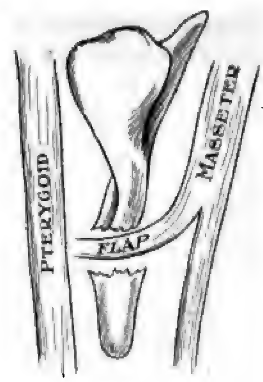


FIG. 101.

FIGS. 100 AND 101.—Rochet's operation. (*After Monod and Vanverts.*)

Step 2.—With chisel, forceps, or Gigli saw divide the bone along the lines marked in Fig. 100, and remove the bone between the lines of section. The amount of bone should be as great as possible, to permit wide range of motion subsequently.

Step 3.—From the deep surface of the masseter dissect a flap about 1½ inches long, with its pedicle above, consisting of about half the thickness of the muscle. Pass the free end of this flap through the breach in the bone and suture it to the pterygoid (Fig. 101). Should the flap from the masseter be insufficient for the purpose, a subsidiary flap may be taken from the pterygoid.

Step 4.—Close the wound.

CHAPTER X

ODONTOMATA

Odontomata are tumors arising from teeth germs or teeth still in process of growth. Bland-Sutton described seven varieties of this tumor besides the simple dental cyst which develops at the root of a dead tooth. The odontomata are often called dentigerous cysts. The chief importance of these tumors is that they are rarely recognized prior to operation, that they are often wrongly diagnosed as malignant neoplasms and the whole jaw needlessly extirpated. The tumors are non-malignant and are readily removable.

Bland-Sutton writes: "In the case of a tumor of the jaw, the nature of which is doubtful, particularly in a young adult, it is incumbent on the surgeon to satisfy himself before proceeding to excise a portion of the mandible or maxilla that the tumor is not an odontome, for this kind of tumor only requires enucleation." The following operation performed by the author explains the principles of procedure. Incision through muco-periosteum over the prominence of the tumor. With chisel, trephine, or bur cut through the shell of bone (about two lines in thickness). In the posterior part of the tumor a cavity was found containing a perfect premolar tooth with thick mucous membrane attached all round its neck. Tooth removed. The mucosa was attached to a purplish, soft, round, grape-like mass which filled the anterior part of the tumor or bone cavity. This was easily shelled out. The cavity left was the size of a hen egg, was smooth and lined with mucous membrane. The root of the first molar projected into the cavity. Extracted this tooth. Partly closed wound and packed with gauze. The tumor was a typical odontoma. After many weeks the cavity closed completely.

A more rapid closure would have been obtained had the operation been performed as follows:

1. Free incision of muco-periosteum over the growth.
2. Reflection of muco-periosteum from over the whole external of the prominent surface of the tumor.
3. Penetration of the bone and removal of the contents of the bone cavity.
4. Removal of all the external wall of the cavity and destruction of the mucous membrane lining the rest of the cavity.
5. Application of the reflected muco-periosteal flaps to the bottom of the cavity. Application of dressings to keep the flaps in position.

CHAPTER XI

EXCISION OF THE CHEEK

tumor is located on the buccal surface of the cheek, is not extensive, and ›t involve the skin, it may be excised through the mouth by an elliptical ı and the wound closed by sutures. Should the amount of mucous mem- and subjacent tissue removed be great, then, when healing has taken place, may result fibrous anchylosis of the jaw. To prevent this contraction, ust fill the defect by means of a graft covered with epithelial tissue. Of :, when the anchylosis is the result of an old burn or similar lesion one must : the scar tissue before implanting the graft.

he Operation.—The tumor or old scar tissue has been excised through the :h, leaving the defect a, b, c (Fig. 102). On the neck trace the flap D, E, F,

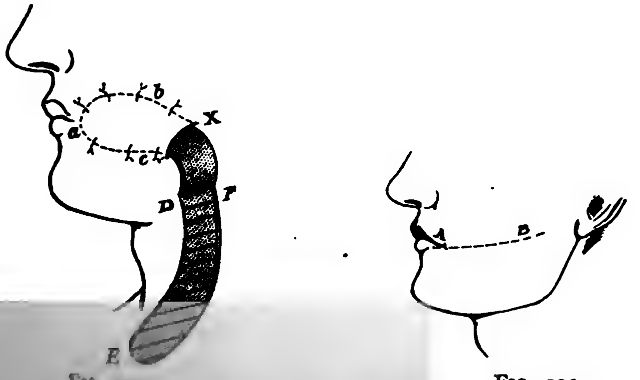


FIG. 102. FIG. 103.

FIGS. 102 AND 103.—Repair of buccal mucosa.

e distal portion of which consists of hairless skin large enough to more than l the defect. Dissect free the flap outlined. Be sure that the pedicle is wide, ick, and so placed that when turned into position its vessels will not be injuri- ly twisted. Make an incision (X, Fig. 102) through the cheek into the mouth. rough this incision pass the flap D, E, F, and suture its edges to the margins the defect a, b, c. After the lapse of ten days divide the pedicle of the flap at nd replace its remnant in its normal position. Close the wound in the cheek. e the wound in the neck [illegible] sliding the edges towards each other and ify by skin grafts. [Th[illegible] the wound in the neck may properly be [illegible]rigin[illegible]

[illegible] tumor through the mouth, although the [illegible] incision A, B (Fig. 103) through the skin [illegible], and thus expose the mucous mem-

brane and tumor (T, Fig. 104). Next excise the tumor and fill the resulting defect by the flap (C, E, D, Fig. 105) taken from the neck (or forehead). Replace the flaps X and Y and secure with sutures.

Shelton Horsley (Journ. A. M. A., Jan. 30, 1915) if necessary provides an epithelial lining for the mouth by means of a flap turned up from the neck or from the tongue. The flap to replace the skin defect, is taken from the forehead

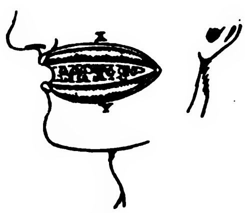


Fig. 104.

Fig. 105.

Figs. 104 and 105.—Repair of buccal mucosa.

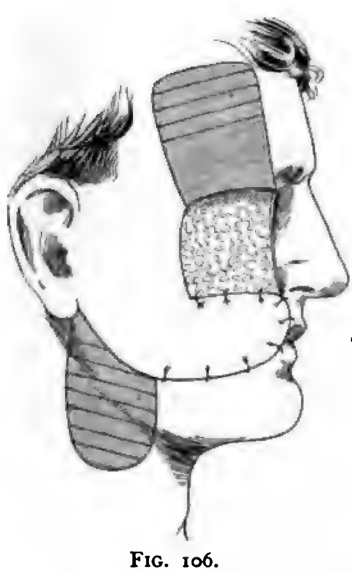


Fig. 106.

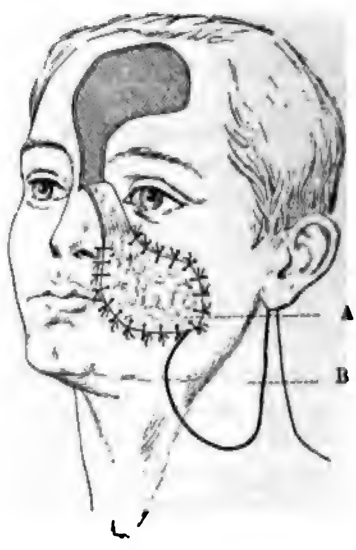


Fig. 107.

Figs. 106 and 107.—Plastic operation on cheek. (*Monod and Vanverts.*)

instead of being provided with the usual pedicle transplantation of the anterior temporal artery is practised according to the method published by Monks (Boston Med. and Surg. Journ., 1898) but of which Horsley was ignorant at the time.

The Operation. Anesthetize preferably by the rectal method.

1. Prepare the cheek by trimming away the scar tissue around the defect and by undermining the skin slightly. If it is necessary to replace the mucosa do so by implanting the flap A, B, C, D (Fig. 108).

2. Outline the flap E, F, G. Make the straight incision G, H along the line of the anterior temporal artery. Expose the artery, but do not injure it or grasp it with forceps. Dissect the artery free along with a considerable amount of surrounding tissue so as to preserve the nerve supply of the vessel. Make the incision H, I through the skin alone and prepare a bed for the artery. Complete the mobilization of flap E, F, G and place it in the defect in the cheek. Place

FIG. 108.—(*Horsley, Journ. A. M. A.*)

the artery, which of course runs into the flap E, F, G into the gutter prepared along the line H, I and suture the skin over it. Unite the flap E, F, G by a *few stitches* to the defect. As the drainage of the flap and not its blood supply is liable to be faulty, plenty of opportunity for escape of blood and fluids must be provided, hence few stitches are used. "By the second day the flap is swollen and becomes a dark purple color. If it is too tense, every few hours a sharp knife can be inserted along the edges of the flap to scrape it a little so as to promote bleeding and relieve the tension. After a week the swelling begins to disappear and new capillaries drain away the blood."

Bardenheuer has devised some excellent aad ingenious methods of repairing defects in the cheek, defects left after the removal of disease or of scar tissue which gave rise to fibrous anchylosis. Fig. 106 represents a case in which the mucous membrane was replaced by a flap of skin taken from the forehead and provided with an enormously wide and reliable pedicle; the skin was replaced by a flap of skin taken from the neck. After healing was secured the pedicles were divided, the wound trimmed, and all raw surfaces on forehead or neck covered

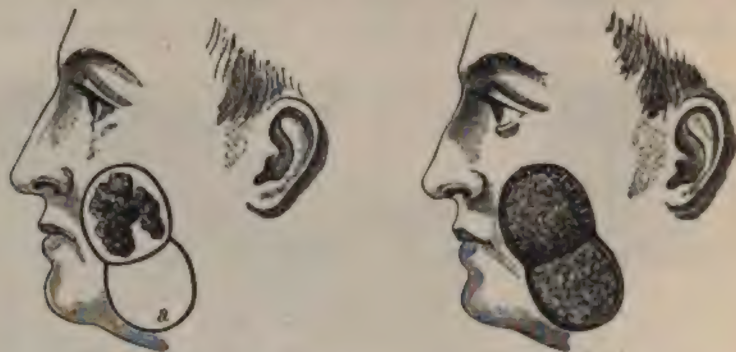


FIG. 109. FIG. 110.
FIG. 109 AND 110.—Kraske's operation. (*Esmarch and Kowalzig.*)

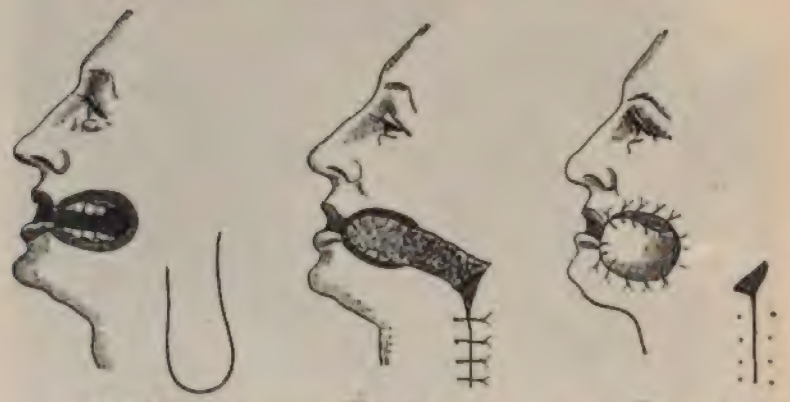


FIG. 111. FIG. 112. FIG. 113.
FIGS. 111, 112, 113.—Israel's operation. (*Esmarch and Kowalzig.*)

by skin-grafts. Fig. 107 represents a case in which Bardenheuer brought a skin-flap down from the forehead. The flap was nourished through a narrow flap which contained the supraorbital artery. The defect in the skin was covered by a flap taken from below.

The above operations are described as suggestive types for the repair of defects in the cheek. The operations of Kraske and Israel are also good types (Figs. 109, 110, 111, 112, 113).

In cases where part of the lower jaw has been removed and where there is a corresponding loss of substance in the cheek Sonnenburg ("Archiv für klin.

.," lxxviii, 820) makes an incision along the corresponding side of the ton- (Fig. 114) and so obtains a flap of tissue covered with mucosa. This flap ıenburg sutures to the freshened upper edge of the defect in the cheek (Fig. . The oral side of the defect being filled as above, the outer or skin side now be covered by an appropriate flap taken from the neck.

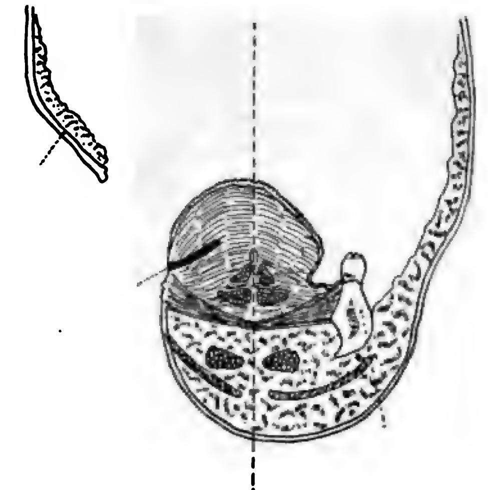


FIG. 114.—(*Sonnenburg.*)

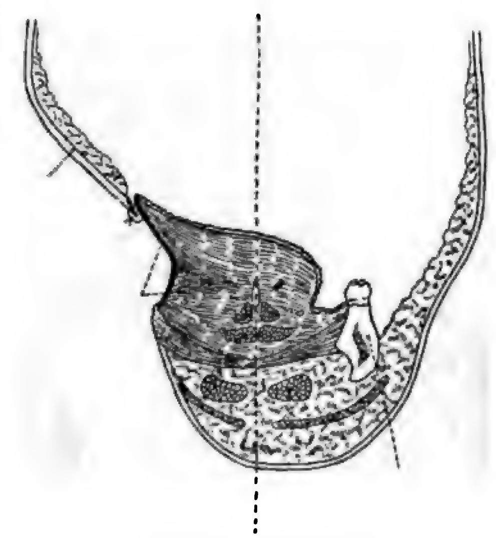


FIG. 115.—(*Sonnenburg.*)

Hotchkiss' Operation.—Planned for cases of extensive cancer of the cheek h involvement of the jaw.

Step 1.—**Make** the incision 1, 2, 3, 8, 4, (Fig. 116) through the skin, and ect the flaps outlined so as to expose the lower border of the inferior max-

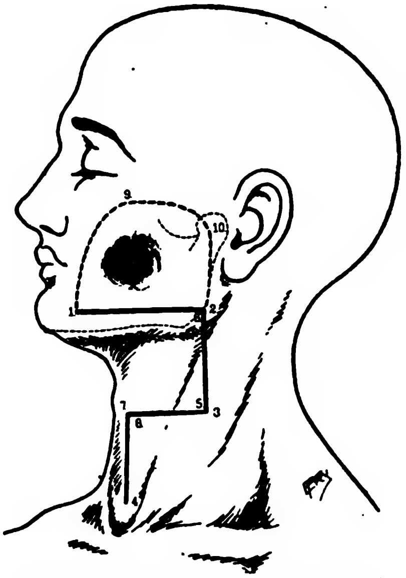


Fig. 116.—(*Hotchkiss, Annals of Surg.*)

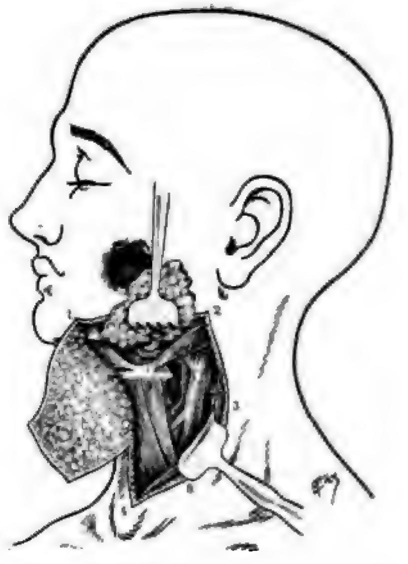


Fig. 117.—(*Hotchkiss, Annals of Surg.*)

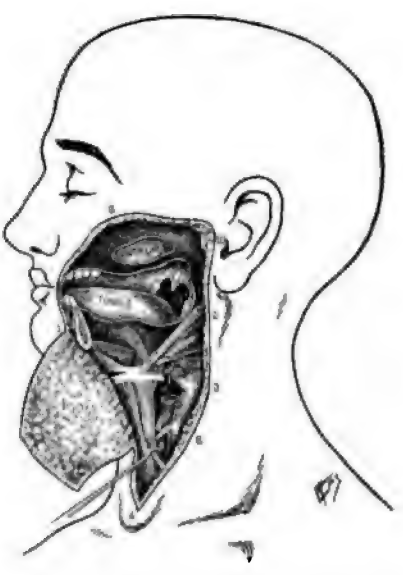


Fig. 118.—(*Hotchkiss, Annals of Surg.*)

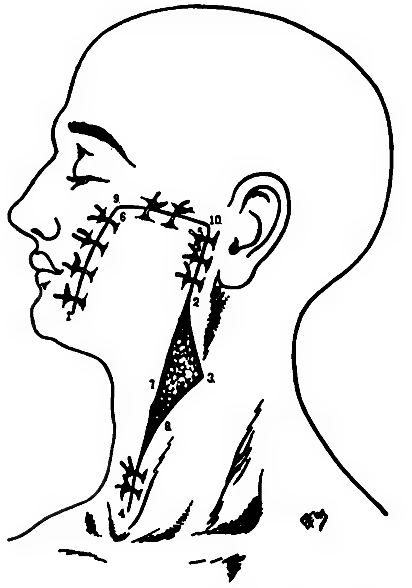


Fig. 119.—(*Hotchkiss, Annals of Surg.*)

al veins and the external carotid artery.

3.—Expose the outer surface of the lower jaw and prepare it for section. the neck wound with gauze. Make an incision all around the disease ace and at a safe distance from the disease (1, 2, 10, 9, Fig. 116). This penetrates the mouth. Divide the lower jaw with a Gigli saw well in the growth. Retract the divided jaw. Divide the floor of the mouth e groove of the tongue severing the mylohyoid and hyoglossus muscles. lower jaw and attached structures outwards, and if the disease involves er jaw remove the affected bone. Disarticulate and remove the lower ng with the diseased tissues (Fig. 118).

4.—In Hotchkiss' cases "the mucous membrane at the side of the tongue ited to the cut edge of the hard palate, the tongue thus being elevated rt of wedge against leakage from the mouth. The edges of the cut s membrane in front and behind this were united by suture and the cut f the mylohyoid muscle was brought up over this line of union of the s membrane, and the skin-flap shown in Fig. 119 was then sutured up to the defect in the cheek. A portion of the incision in the neck was left un-ed and filled with loose gauze packing extending up to the glenoid and tem-l fossæ" ("Annals Surg.," Oct., 1908).

CHAPTER XII

LOWER LIP

Epithelioma is the most common cause for removal of the lower lip. The classical method of removing labial cancers is by a V-shaped incision. This method is applicable to cases in which not more than two-thirds of the width of the lip is involved. The resulting deformity is slight.

The operation is performed as follows: A general or local anesthetic having been administered, an assistant controls the coronary arteries with his fingers and thumbs; the surgeon rapidly cuts through the whole thickness of the lip on each side of the tumor. The two cuts thus made meet at an angle below the tumor, which is now removed. Before the assistant relaxes his control of the coronary vessels the surgeon applies silk or silkworm-gut sutures, either through the whole thickness of the lip or with the exception of the mucous membrane. The sutures are tied and form a sufficient guard against hemorrhage.

When performed as above, the operation is very speedy; so speedy, in fact, that the surgeon may inadvertently make his incision approach a little too close to the tumor. In such operations there is usually nothing to be gained and much may be lost through great speed. A slight modification in operating leads to greater deliberation and hence greater thoroughness.

The surgeon seizes the tumor and lower lip between the finger and thumb of the left hand, and pulls them forwards and upwards in such a way as to guard against blood entering the mouth. Beginning on the lip margin, at least one-fourth of an inch from the growth, a curved incision is made downwards until the lower limits of the tumor are passed. This incision is made *to* but *not through* the mucous membrane. Bleeding vessels are caught up with hemostats. A similar incision is made on the opposite side, and only after bleeding is stopped is the mucous membrane divided and the growth removed. The wound is closed as in the previous operation. Many surgeons prefer to stitch the mucous membrane with catgut and close the rest of the wound with silk or silkworm-gut. As a matter of routine, the glands through which the lymphatics of the lip drain should be removed even if not enlarged. He would be a bold fool who would say a field had no seed in it because no sprouting verdure was visible. Experience seems to show that it is unnecessary to remove the lymphatics leading from the tumor to the lymph nodes, although theoretically such ought to be removed. For the sake of obtaining aseptic healing of the wound made in removing the lymph glands this part of the operation may be performed through a separate incision which is closed before the primary disease is attacked. "The capillary plexuses of the skin and mucous membrane are continuous at the free border of the lips. The ducts of the upper lip, of which there are about four on each

side, pass to the submaxillary nodes. From the lower lip the trunks from near the angle of the mouth pass to the submaxillary nodes, while those from the centre of the lip pass to the submental nodes. There are from two to four subcutaneous ducts and from two to three submucous ducts on either side. The collecting trunks passing to the submaxillary nodes do not anastomose, and the same is true of the submucous ducts of the lower lip. The subcutaneous ducts, on the other hand, passing to the submental nodes, anastomose freely—an important fact in connection with the extension of cancer of the lower lip." ("Morris' Human Anatomy.")

The submental nodes ought, therefore, to be removed on both sides. Remember that some lymph nodes are closely attached to the submaxillary salivary glands and hence these glands should be excised on the affected side. A

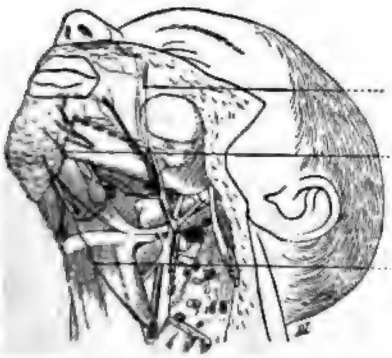


FIG. 120.—The lymphatics of the lips. (*After Dorendorf.*)

ontinuation downwards of the incision for the removal of the tumor, the V cision being converted into a Y, and elevation of the skin on each side of the cut ive excellent access to the structures requiring removal.

Bloodgood found that excision of the lip and glands, when there was no aprent glandular involvement, resulted in twenty cures among twenty-one cases. hile the same operation gave six cures out of twelve cases when metastasis was emonstrably present in the glands. In the six cases in which recurrence ok place it was local in one and in the cervical glands in five.

When there is palpable glandular involvement in the neck the operation ecomes similar or practically identical with that required in cancer of the tongue. See Butlin's, Crile's, Maitland's methods described in chapter on the Tongue.)

Very superficial cancers of the lip may be removed by a curved, more or ss horizontal incision, the mucous membrane and skin being subsequently ewed together.

A large number of methods for the removal of cancers of the lower lip and r remedying the resulting deformity will be found sketched at the end of this rticle.

Regnier's Operation.—*Step 1.*—The tumor and the *whole* of the lower ip, from one angle of the mouth to the other, are removed by a curved inci-

sion. In making this incision it is well to have all bleeding arrested before the mucous membrane is divided and the mouth is penetrated.

Step 2.—The skin and mucous membrane at the edge of the wound are united by sutures (A, Fig. 121).

Step 3.—From the lower edge of the middle of the upper lip measure downwards to the lower edge of the middle of the lower jaw (*e.g.*, call the distance 2¼ inches). From the middle of the wound (A, Fig. 121) measure downwards and mark a point the same distance below A as the mental process is below the edge of the upper lip (in our example, 2¼ inches). Take a point, B, in the middle line, ¾ inch lower than the above (*i.e.*, in our example, 3 inches below A). In the submental region or in the neck, as the case may be, make a curved incision parallel in the wound in the lower lip, and having the point B as its centre. This curved incision must be from 5 to 6 inches in length.

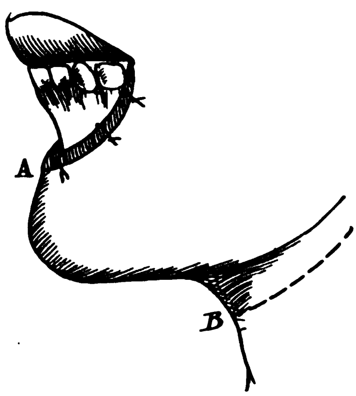


FIG. 121.

FIG. 122.

FIGS. 121 AND 122.—Regnier's operation.

Step 4.—Through the incision at B dissect the skin-flap, A, B, from the subjacent tissues in such a way as to enter the mouth at the line of reflection of the mucous membrane from lip or cheek to gum. In this way a vizor-shaped or double-pedicled flap is formed and can be slid over the lower jaw to re-form the lower lip. The lower edge of this flap is sutured to the periosteum at the lower edge of the jaw (Fig. 122).

Step 5.—A space, C, is left in the submental region through which any enlarged glands may be removed. Ogston maintains that, when the submaxillary gland is enlarged and even slightly adherent to the bone, the bone is probably already involved in the disease and ought to be removed. If this is the case, then it is quite feasible to remove the whole thickness of the bone involved, along with the gland, through the triangular space C. The skin of the neck being very lax and mobile, it is a simple matter to cover at least a large part of the space C with skin. Any uncovered portions may be grafted according to the Thiersch method.

Dressings.—Iodoform gauze should be loosely packed between the newly

formed lower lip and the upper part of the external surface of the lower jaw. Externally the usual antiseptic dressings may be applied. The mouth should be frequently washed with a weak solution of permanganate of potash and the dressings changed as required.

Regnier's operation is capable of being modified to meet many conditions, and very great deformities may often be avoided by its means. To the writer it has given great satisfaction.

DOWD'S OPERATION

Step 1.—Make the incisions A, B and C, D below and parallel to the lower jaw. Be careful to leave the point X (Fig. 123) attached to the jaw. Expose and remove the fatty and lymphatic tissue of the whole submental and submaxillary region. Remove also the submaxillary salivary glands. If the lymphatics above mentioned are visibly and palpably enlarged, continue the incisions backwards and expose the carotid packet of vessels. Remove the lymphatic glands in this region whether they are palpably enlarged or not.

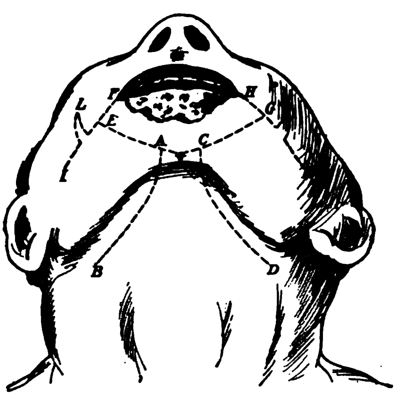


FIG. 123.—Dowd's operation.

Step 2.—Remove the disease by means of the incisions A, E, F; C, G, H; A, C. These incisions should be ½ to ¾ inch distant from the disease.

Step 3.—Make the incisions I, E and G, K (each two inches or more in length), down to but not through the buccal mucosa. Divide the mucosa along lines at least ⅓ inch higher, so as to form a flap which may be stitched to the skin and serve as mucous membrane for the new lower lip.

Step 4.—Unite the raw surface A, E to C, G with sutures. The wedge-shaped incisions L and M may aid in the approximation of the new lower lip.

Step 5.—Close the wounds A, B and C, D, after providing for drainage.

Trendelenburg's position ought to be used throughout the operation. In operating on cancer of the lip it is a good rule, where possible, to begin by dissecting out the lymphatics which *may* be diseased. It is, of course, imperative to remove all evidently involved lymphatics, but it is prudent to go further and remove the *apparently* unaffected ones next in order. For example: the sub-

mental and submaxillary group of lymphatics appear healthy, or but very slightly diseased: remove them and then excise the primary disease of the lip as well as perhaps the fatty connections between the primary and the secondary foci of disease; again, the submental and submaxillary group are evidently diseased: expose the carotid group of lymphatics, excise them, as well as the submaxillary, etc. One great reason for beginning with the lymphatics is that by so doing the mouth is not penetrated until the difficulties of the operation are practically ended.

W. S. Sutton devised an ingenious and successful method of removing tumors involving both upper and lower lips at the angle of the mouth ("Journ.

FIG. 124.—Sutton's operation. (*Sutton.*)

A. M. A.," Aug. 20, 1910). Fig. 124 is self-explanatory. Grant's operation is sufficiently explained by Figs. 125 and 126.

Nélaton and Ombrédanne recommend the two following operations as the methods of choice in cancers of different extent.

Method A.

Step 1.—Excise the cancer by a V-shaped incision. From the apex of the V make one or if necessary two incisions parallel to and a finger-breath below the border of the lower jaw, outwards to the line of the carotid artery (Fig. 127). Excise the lymphatics extensively.

Step 2.—Close the wound by suture, after providing for drainage (Fig. 122). Closure of the wound produces a very ugly deformity of the upper lip. To correct this make an angled incision E, B, C (Fig. 128) on each side of the

mouth. Suture the cut surface E, B to the cut surface B, C. This restores the upper lip. Along the line E, D, C unite the buccal mucosa to the skin. This gives a presentable lower lip (Fig. 129).

Method B.—For very extensive lesions.

Step 1.—Excise the tumor, preferably by incisions which form a triangle with its apex below, so that a cut may run down from the apex to expose the lymphatics beneath the jaw.

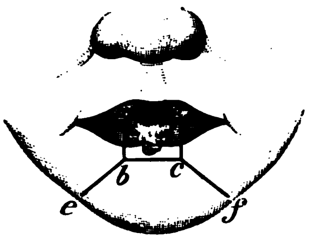


FIG. 125.—Grant (*Bryant's Op. Surg.*)

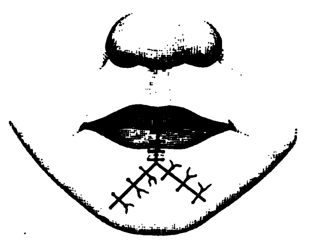


FIG. 126.—Grant (*Bryant's Op. Surg.*)

Step 2.—On each side proceed as follows: From the angle of the mouth make an incision (A, B, Fig. 130) directed towards the inferior border of the tragus. Divide ***the skin only.*** Open the mouth. Mucous membrane exists under the anterior portion of the cut A, B. Divide the mucous membrane parallel to but about ⅛ inch above the skin incision. (By suturing the mucosa to the skin a red border is provided for the new lower lip.) Make the skin

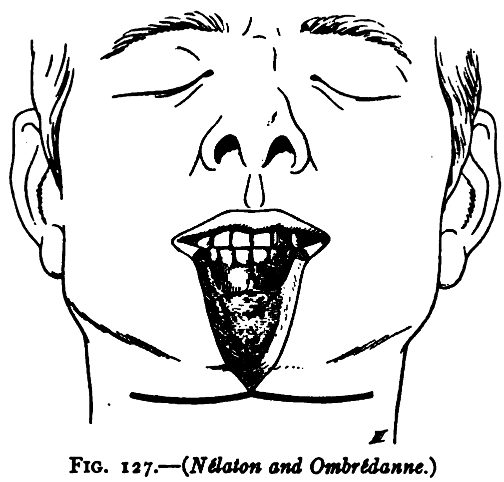


FIG. 127.—(*Nélaton and Ombrédanne.*)

incision B, C parallel to the wound made in the excision of the disease. The lower end of the cut B, C, is about a finger's breadth below the lower border of the lower jaw. In making the cuts A, B and B, C do *not* injure the parotid. Reflect the flap outlined by the cuts AB, BC; to do this it is necessary to divide the mucosa vertically along the anterior edge of the masseter. Be careful

not to divide the facial artery where it crosses the border of the lower jaw, but separate it, with the flap, from the jaw.

Step 3.—Clear away the lymphatics and the submaxillary glands but carefully preserve the facial artery; if necessary, the facial vein may be sacrificed.

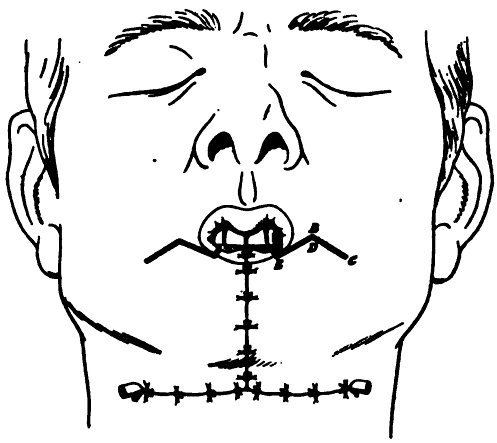


FIG. 128.—(*Nélaton and Ombrédanne.*)

Step 4.—Suture the mucosa to the skin on the upper edge of the flap (see Step 2) so as to form a red border for the new lower lip (X, A, Figs. 131 and 132).

Step 5.—Suture the lower edge of the mucous membrane of the new lip to the cut edge of the mucous membrane on the lower jaw (L, L, Figs. 131 and 132).

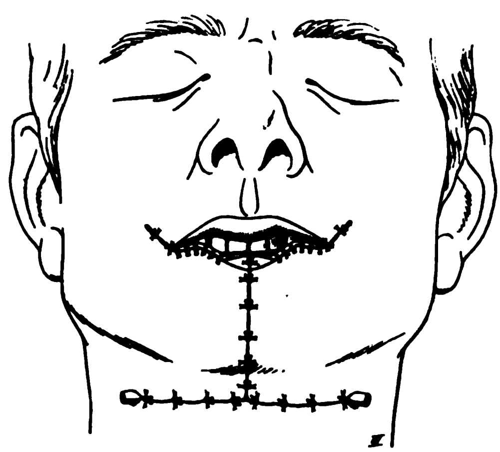


FIG. 129.—(*Nélaton and Ombrédanne.*)

This forms the line of reflection of the mucous membrane between the lip and the jaw. The rest of the operation is sufficiently explained by Fig. 132 and 133.

Clark Stewart's operation ("Journ. A. M. A.," Jan. 15, 1910) gives good exposure of the submaxillary lymph nodes and permits of the excision of the lymph nodes, submaxillary glands and the tumor in one piece.

"The first incision extends just below the jaw from one angle to the other and cuts the skin and platysma muscle, which are then carefully dissected

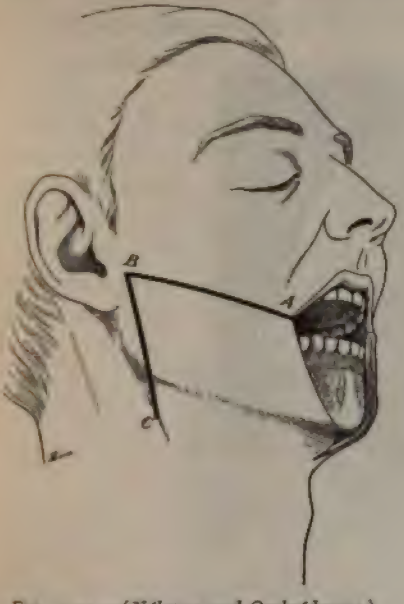


FIG. 130.—(*Nélaton and Ombrédanne.*)

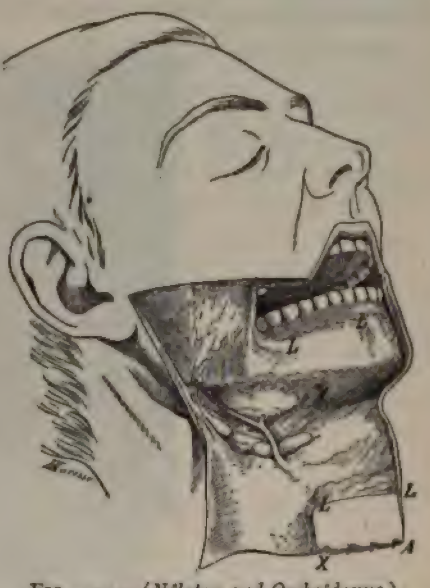


FIG. 131.—(*Nélaton and Ombrédonne.*)

FIG. 132.—(*Nélaton and Ombrédonne.*)

FIG. 133.—(*Nélaton and Ombrédonne.*)

down to the level of the thyroid cartilage (Fig. 134). All tissues down to the muscles are then sectioned at this line and a clean dissection is made elevating all loose connective tissue, lymph nodes, etc., in a flap which extends laterally

to the great vessels on each side. The facial artery and vein are ligated and the submaxillary glands are loosened and raised in the flap on each side. Incisions are now made at each side of the epithelioma far enough away to include all infiltrated tissue, and these are carried down to the cross-section already made.

FIG. 134.—(*Stewart, Jour. A. M. A.*)

The lateral flaps are now dissected free from the jaw, keeping close to the skin at the lower part to avoid lymphatics, and finally the intervening central mass is loosened from the jaw and removed. This contains the tumor and a fan-shaped mass of skin and the deeper tissues attached to the lymph nodes of

FIG. 135.—(*Stewart, Jour. A. M. A.*)

the neck, and the submaxillary gland by a loose flap of tissue which contains the connecting lymphatics.

The submaxillary glands should always be removed, not because they are infected in early cases, but because there is regularly a lymph node attached

to each which is one of the first to be involved. In cases in which not over three-fourths of an inch of the vermilion edge of the lip has been removed, simple suture of the wound with drainage of the submaxillary fossæ completes the operation. In cases in which the mouth must be extended on account of more extensive removal of the lower lip, the procedure shown in the drawings is convenient.

The mouth is broadened by a straight incision outwards at either or both angles, and this incision is carried down to but not through the mucous membrane; the latter is then cut one-half inch higher and stitched to the raw surface of the new lip (Fig. 135). To avoid puckering of the upper lip a triangle of the skin is taken out of the cheek to allow of the smooth drawing together of the lower lip (Fig. 136). The new chin should be sutured to the soft tissues over the lower jaw to exclude mouth fluids from the neck wound."

FIG. 136.—(*Stewart, Jour. A. M. A.*)

Mayo's Operation.—*Step* 1.—Make a collar incision through the skin and platysma ¾ inch below the mandible from one sternomastoid to the other. Reflect the skin and platysma down to the hyoid bone and up to the mandible. Remove all fascia and fat as well as the submaxillary salivary glands from the submental and submaxillary triangles on both sides. Ligate the facial arteries and veins but preserve the hypoglossal and lingual nerves.

As soon as the glands have been removed from one side have them examined microscopically while those on the other side are being removed. If they are innocent of cancer complete the operation by suturing the platysma and then the skin after providing for drainage and proceed to the excision of the lip. If the glands are cancerous further dissection is essential as described in Step 2. If they are not cancerous proceed to Step 3.

Step 2.—Make an incision along the sternomastoid muscle, reflect the skin and platysma sufficiently to expose the whole region of the sternomastoid on that side of the neck from which cancerous glands were obtained. Divide the

sternomastoid at its lower end and from below up make a block dissection of all the glands and gland-bearing fascia of the entire neck, including the anterior and posterior deep jugular glands up to the mastoid process. Removal of the sternomastoid is necessary to a complete dissection. Be very careful to clean out the glands in the posterior part of the submaxillary triangle.

FIG. 137.—(*Beckman.*)

Provide for drainage. Close the wound. Delay operation upon the lip until danger from infection of the great cervical wound is past.

RESULTS AFTER OPERATION FOR CANCER OF THE LOWER LIP (BECKMAN, MAYO CLINIC, 1913)

Group	No. of cases	No. operated	Traced	Not traced	Cured	Not cured	Inoperable	Per cent. cured
I. Clinical diagnosis only	25	2	6	19	2	23	17	......
II. Primary radical operation	126	126	99	27	83	16	......	83.8
Glands involved	18	18	18	......	9	9	......	50.0
III. Late radical operation	25	25	20	5	14	6	......	70.0
Glands involved	12	12	12	0	4	8	......	33.3
IV. Glands removed one side or incomplete	5	5	5	0	2	3	......	40.0
V. Local excision only	18	18	15	3	11	6	......	73.3

.—Figure 137 sufficiently elucidates the removal of the disease in the

CHIN AND JAW

ionally an operable cancer involves the soft parts of the chin, the floor uth, and a portion of the lower jaw. The following method has proved such cases:

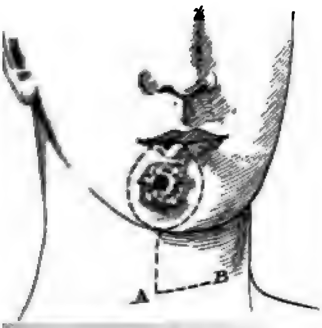


FIG. 138.

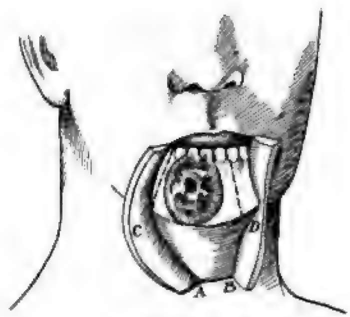
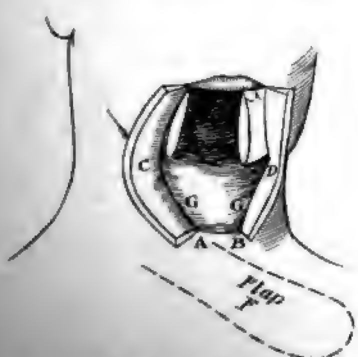


FIG. 139.

[illegible] 1.—A stout thread is passed through the tongue so as to have command [illegible] organ.

[illegible] 2.—An incision is made through the skin around the tumor. From [illegible] part of this a cut is made downwards through the skin of the sub- [illegible] and neck to a point A (Fig. 138). The cut A, B, is made through



[illegible]—Author's operation for epithelioma of the chin and jaw.

[illegible] around the tumor is deepened until the bone is reached, [illegible] should not be penetrated until all bleeding vessels have been [illegible] thus, time is not wa[illegible] by the necessity of swabbing [illegible]

[illegible] A, C and B, D (F[illegible] eflected, giving easy access [illegible] mus [illegible] w is divided by a chain or [illegible]

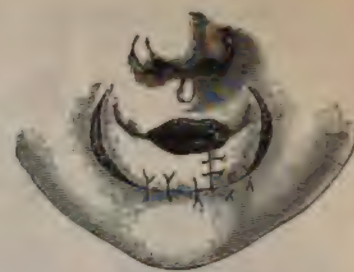


Fig. 141. Fig. 142.

Figs. 141 and 142.—Bruns. (*Esmarch and Kowalzig.*)

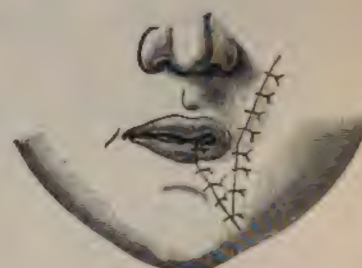


Fig. 143. Fig. 144.

Figs. 143 and 144.—Estlander. (*Esmarch and Kowalzig.*)

Fig. 145. Fig. 146.

Figs. 145 and 146.—Dieffenbach. (*Esmarch and Kowalzig.*)

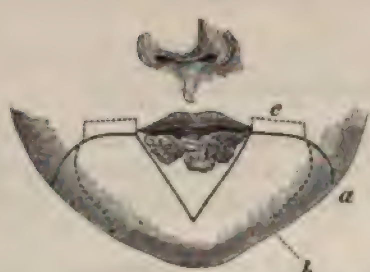


Fig. 147. Fig. 148.

Figs. 147 and 148.—(*a*) Jaesche; (*b*) Trendelenburg. (*Esmarch and Kowalzig.*)

Step 4.—Posteriorly to the tumor and from below upwards the floor of the outh is divided in such a manner that all bleeding is *invited* and arrested before scissors or knife enters the mouth.

Step 5.—It is now easy to remove all the diseased structures—chin, jaw, or of mouth, glands, etc., *en masse.*


FIG. 149.


FIG. 150.

FIGS. 149 AND 150.—Burow. (*Esmarch and Kowalzig.*)

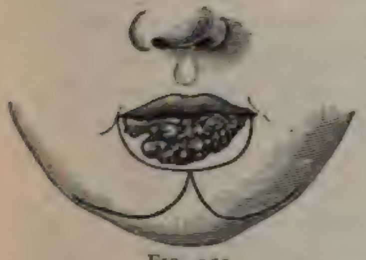


FIG. 151.

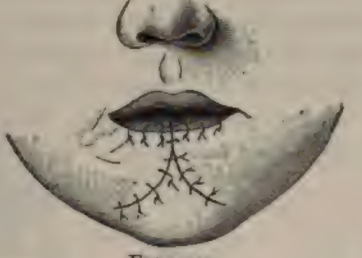


FIG. 152.

FIGS. 151 AND 152.—Blasius. (*Esmarch and Kowalzig.*)

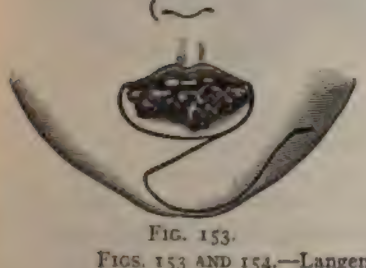


FIG. 153.


FIG. 154.

FIGS. 153 AND 154.—Langenbeck. (*Esmarch and Kowalzig.*)

Step 6.—If possible, the edges of the oral mucous membrane should be ited by silk or catgut sutures. The skin-wound is closed by silkworm-gut.

Dressings.—The floor of the mouth should be lightly packed with iodoform uze. The external wound should be covered by an *antiseptic* dressing. equent washing of the mouth with a weak permanganate of potash solution necessary. Food ought to be given through the stomach-tube, though the tient may drink water if he so desires. It is important in all such cases to

encourage the patient to leave his bed as early as possible. This helps to avoid the great danger in such cases, viz., septic pneumonia.

Should the first part of Step 6 of the previous operation be impossible owing to lack of mucous membrane, then an attempt may be made to supply the defect as follows: In the neck (where hairs are absent) trace out a flap of skin (F, Fig. 140) in such a position and of such a size that, allowing for shrinkage

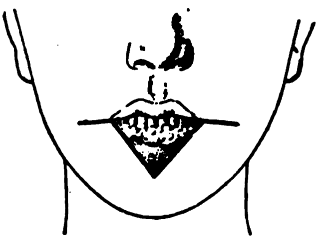


FIG. 155.

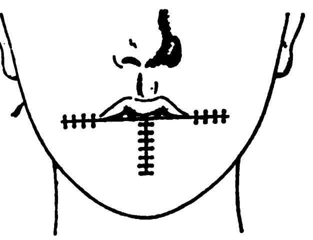


FIG. 156.

FIGS. 155 AND 156.—Trelat. (*Monod and Vanverts.*)

it can be made to fit into the floor of the mouth. Turn the flap F up and stitch its *distal* or free end to the *anterior* portion of the mucous membrane wound. The most posterior stitches unite the mucous membrane of the side of the mouth near the root of the tongue to the raw edges of the flap near its pedicle. This gives an epithelial lining to the floor of the mouth. The flaps A, C and B, D (Fig. 140) are now sutured over flap F; both flaps, A, C and B, D, having been

FIG. 157.

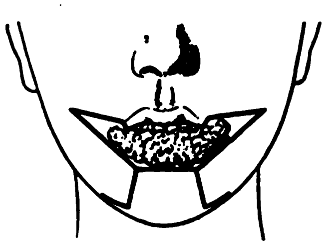


FIG. 158.

FIGS. 157 AND 158.—Serre. (*Monod and Vanverts.*)

split (G) to permit the passage of flap F into the mouth. The wound left by the transplantation of flap F is to be closed by sutures or by Thiersch's skin-grafts. Of course, a secondary operation will be necessary to close the hole G and to divide the pedicle of flap F.

Several well-known methods of excising the lower lip and repairing the defect are illustrated by Figs. 141 to 158.

CHAPTER XIII

UPPER LIP

Excision of the upper lip is usually demanded because of malignant disease, but scars resulting from infective lesions, burns, etc., may require excision and repair.

As in other regions, when operating for malignant disease, it is necessary to know the anatomy of the lymphatics as the lymph nodes into which the diseased area drains must be thoroughly removed. The lymphatics of the upper lip pass into the submaxillary lymph nodes but on their way they may pass through certain facial nodes, viz., (a) the infra-maxillary and supra-maxillary nodes resting on the lower jaw near where it is crossed by the facial artery, (b) the anterior and posterior buccinator nodes, superficial to the buccinator fascia,

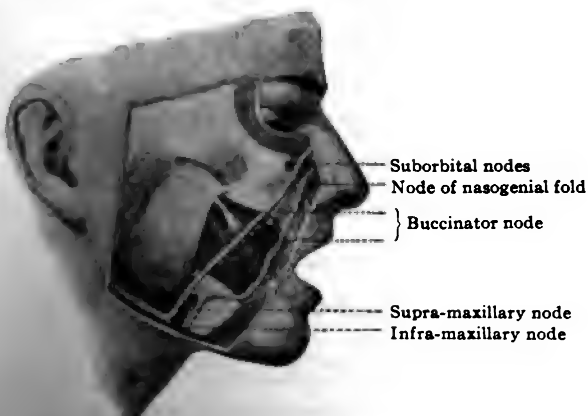


FIG. 159.—The facial nodes. (*Morris after Buchbinder.*)

...necting the lower margin of the ear and the angle of the ...des lie near where the parotid duct perforates the buccinator ...r nodes lie between the facial artery and vein (Fig. 159). ...ms from the upper lip remember that the mid- ...developmental origin as the columella nasi and ... the former to the latter structure. Removal ...y requires description; repair of the resulting ...of the edges of the defect must be accomplished ...n the sutures; without too great puckering of

the lower lip; without disfiguring twisting of the angles of the mouth which might give the expression of a fixed sneer; without displacement of the *alæ nasi* sufficient to interfere with the patency of the nostrils.

Method 1.—The neoplasm is at or near the middle line and is not of great size. *Step* 1.—Make the vertical incision AB and A'B', Fig. 160, on each side of and three-fourths of an inch distant from the disease. Cut through the whole thickness of the lip. Continue the incisions upwards curving around the alæ of the nose to the points D and D'. By a transverse cut join the points B and B' thus separating the alæ of the nose from the cheeks and upper lip and dividing the columella nasi. Remove the diseased segment of the lip. Attend to hemostasis.

Step 2.—Everting the remnant of the lip on one side make an incision through the mucosa to the bone along the reflection of the mucosa from the cheek to the upper jaw. With blunt and sharp dissection separate the soft parts from the bone to such an extent that the whole cheek is fully mobilized. Do the same on the opposite side.

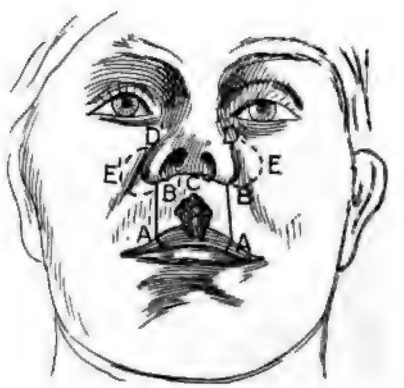


FIG. 160.

Step 3.—Try to approximate the cut surfaces AB and A'B'. If tension is too great, mobilize the cheek more thoroughly. This mobilization may be very extensive and without danger *if* the surgeon "hugs the bone" in carrying it out. When AB is approximated to A'B' the cuts BD and B'D' often become puckered and press objectionably against the *alæ nasi* causing obstruction of the nostrils. To avoid this excise the segments of cheek BED and B'E'D'. Suture AB to A'B' as in hare-lip. Suture the divided columella to the new upper lip. The upper lip may be repaired in this fashion after fully three-fourths of it has been excised.

If there is much puckering of the lower lip resulting from the operation it may be corrected by an operation the same as that described for the lower lip (p. 116) the lines of incision being of course reversed.

During the operation the facial lymph nodes may be looked for and removed. On completion of the operation remove the submaxillary nodes through a special incision and if necessary remove other suspected cervical nodes.

Method 2.—Lenthal Cheatle's operation. At a distance of at least three quarters of an inch from the tumor make the vertical incision AB, Fig. 161, through the whole thickness of the lip. Continue the incision along the curved line BCD a short distance lateral to the groove separating the *ala nasi* from the cheek. On the opposite side of the growth make the corresponding incision A'B'C'D'. From the point D make an incision along the *ala nasi* groove, skirting the ala and cutting it off from the lip. Do the same on the opposite side. Divide the columella nasi, sacrificing a part of its base. Remove the area of lip and cheek between the incisions ABCD and A'B'C'D'.

To facilitate approximation of the edges of the wound make the two curved incisions BE and B'E' about 1½ inches long, through the whole thickness of the cheek. These incisions must *not* injure Stenson's duct which is easily seen in the mouth and avoided. Through the incisions BE and B'E' look for the buccinator lymph nodes and remove them if they are present. Suture the wound AB to the wound A'B'. Close the curved incisions beside the *alæ nasi*. Suture the columella nasi to the new upper lip.

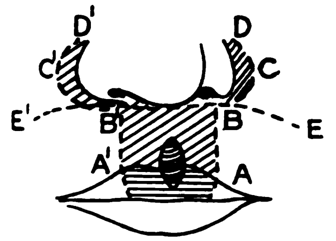


FIG. 161.

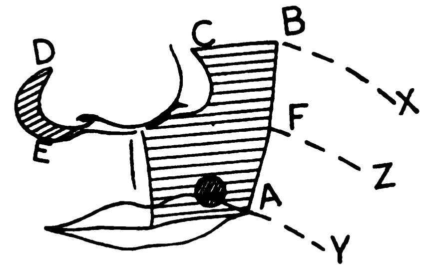


FIG. 162.

Method 3.—The disease is not extensive and is situated in the lateral portion of the lip.

Lenthal Cheatle's Operation.—Three-fourths of an inch internal to the disease divide the lip vertically from its margin up into the nostril or to the columella. From the point A, Fig. 162, three-fourths of an inch external to the disease, at or near the angle of the mouth make an incision AB upwards and outwards towards the external canthus of the eye. The upper end of the incision is on the level of the upper end of the *ala nasi*. Make the incision BC down to the bone. From the point C make an incision following the curve of the *ala nasi* to meet the original vertical incision.

Remove the disease along with the tissues in the shaded area in Fig. 162. Repair must be effected by bringing the opposite half of the upper lip over to meet the edge of the wound AF. To do this without undue tension divide the connections between the remnants of the lip and the jaw; cutting against the bone, widely separate the tissues of the cheek from the bone on the healthy side. By incision separate the *ala nasi* of the healthy side from the cheek and from the lip. To avoid puckering of tissues excise the crescent of tissue DE, Fig. 162.

Divide the columella at its junction with the upper lip. If tension has been sufficiently relieved the remnant of lip can now be brought near the wound AF. To prevent puckering of the angle of the mouth and to relieve tension make the incision AY outwards and downwards from the angle of the mouth, through the whole thickness of the cheek. From the point F on the level of the nostril, make the incision FZ through the whole thickness of the lip. From the point B make the incision BX down to the bone. Reflect the flap ZFBX and excise the buccinator lymph nodes. Suture the wound AF to the remnant of the upper lip. Suture the wound BF to the ala nasi. Suture the columella to an appropriate point on the new upper lip. Excise the submaxillary lymph nodes.

Method 4.—The disease is extensive. Excise the whole upper lip.

Nélaton-Ombrédanne Operation.—Trace the flap ABCDE on each side of the defect (Fig. 163). "The side AB is formed by the border of the defect and in length is a little more than one-half the transverse diameter of the defect. Perpendicular to this side, we trace the line BC slightly concave upwards and

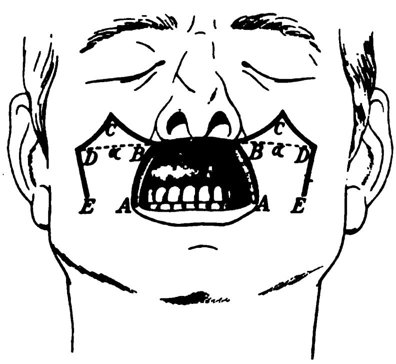


FIG. 163.—(*Nélaton and Ombrédanne.*)

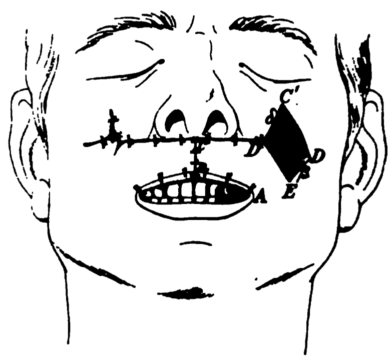


FIG. 164.—(*Nélaton and Ombrédanne.*)

shorter than the vertical diameter of the defect. The result of this will be that the flap when transposed will be a little too long and not quite deep enough but the elasticity of the skin will permit a sufficient gain in the depth at the expense of the length of the flap when sutures are being inserted. Mark the point E, 2 to 2½ cm. (¾ to 1 inch) horizontally outwards from the angle of the mouth; between and equidistant from the points C and E choose the point D which must be about 1 cm. external to an imaginary line uniting C and E. Join CD by a line slightly concave externally. Join DE by a straight line. This completes the tracing of the flap.

The cuts AB and DE penetrate into the mouth. The cuts BCD penetrate to the bone. Divide the reflection of the mucous membrane between the jaw and cheek; and dissect the flap BCD from the bone. The flap ABCD is covered with mucosa except at its point. Along the edge AB suture the mucosa to the skin so as to form a red edge for the new lip, if necessary excising a few millimeters of skin to make the mucosa more prominent. Suture the edge BC to its homologue on the opposite side (Fig. 164); the incision BC being slightly concave

its suture makes a little prominence on the free border of the new lip. When inserting the sutures begin with those in the mucosa. The curve of the incision CD fits it well for its new position under the nose. In closing the resultant defec DC'D'E do not try to unite the two sides of the rectangle which are closest to each other; this would deform the new lip giving it a horrible fixed sneer. Suture the point S to the point B so as to form a sort of star into the branches of which a few suutres may be inserted.

ANGIOMATA OF THE FACE

Angiomata of the face when small may require no treatment; when larger they may be treated by the application of "dioxide" snow or by excision; when superficial and extensive their owner may treat them with resignation but when pulsatile or very large, deforming and threatening to life, more active treatment may be necessary. Excision is often too dangerous and disfiguring. Ligation is inefficient. Injection of coagulating materials is commonly insufficient and involves grave dangers from embolism. Morestin (Rev. de Chir., Feb., 1914) has injected solutions of formalin to kill or "fix" the diseased tissues but precedes the injections by ligating the principal afferent and efferent vessels. The temporary cessation or lessening of the local circulation lessens the dangers from embolism and increases the efficiency of the injections. Morestin's formalin solution consists of equal parts of formalin, 90 per cent. alcohol and glycerine, of which any amount from 1 c.c. to 12 c.c. or more may be injected according to circumstances. The injections may require to be repeated several times but no new injection should be made until the reaction from the previous one has subsided.

The Operation.—A general anesthetic is necessary in the first operation; if the injections require to be repeated the tissues are so altered that no anesthetic is required in the later operations.

Step 1.—Ligation of the Vessels.—According to the case ligation is practised on one or both sides. Bilateral ligation is proper when the lesion is very extensive, passes over the middle line and is pulsatile.

Make an oblique transverse incision whose center is on the anterior margin of the sternomastoid muscle one finger's breadth below the angle of the jaw. Retract the sternomastoid. Penetrate cautiously between the facial and external jugular veins. According to the site and extent of the lesion tie the facial vein, or the facial and external jugular or even the internal jugular (this last of course only on one side). It is best to place the ligatures around the veins but not to tie them until after the arteries have been tied.

Recognize the external carotid artery opposite the tip of the greater horn of the hyoid. Pass a ligature round the artery; expose its principal branches (facial superior thyroid, lingual) and tie them separately. Unless these branches are tied, anastomosis is so quickly established as to render useless the ligation of the main artery. Close the wound.

Step 2.—Charge a syringe with the fixative solution and arm it with a long,

fine needle. Introduce the needle through the skin at the periphery and push it through the tumor mass. Slowly withdraw the needle at the same time expressing the contained solution drop by drop. Do not inject any of the solution close to the skin or mucous membrane, otherwise sloughing will occur. Repeat the injection until the whole of the angioma has been injected (in some very large tumors it is better to inject one segment of the tumor at a time).

Morestin writes: "In pulsatile angiomas the dose of solution must be large even although it may cause massive sloughing; the dangers from the disease justify the risk. When the integument is diseased it is difficult to obtain a cure without greater or less destruction of the skin but in these cases it is preferable not to attack the superficial parts of the disease at the first sitting, they may be treated later."

"A few hours after operation swelling begins and increases to very large proportion during three or four days, but there is comparatively little discoloration. Pain as a rule is slight and ephemeral. General symptoms are usually absent. After four or five days the swelling begins to diminish. The tumor itself persists for a time as a hard mass but little by little this softens and the tissues may become quite pliable."

CHAPTER XIV

HARE-LIP

Time to Operate.—On the whole, it may be taken that it is better to operate after the patient has passed the first two months of life than at an earlier period, although many surgeons operate by choice within a week or two of birth.

Position of Patient and Surgeon.—Chloroform having been administered, the patient should be put in Rose's position. The shoulders being supported on a pillow, the head is allowed to hang backwards over the end of the table. In this posture the anterior nares are at a *lower* level than the entrance to the trachea, and thus it is easier for blood which has gathered in the nose or pharynx to escape through the nares than to be aspirated into the lungs. For the same reason much trouble caused by the collecting of blood in the pharynx is obviated. Trendelenburg's position has the same advantages. The surgeon sits with his back to the window, opposite the patient's head. The first assistant stands beside the patient's left shoulder.

Fundamental Principles of Hare-lip Operations.—1. Tension must be relieved, so that the function of the sutures is practically merely to hint to the edges of the cleft that they must stay in apposition.

2. The edges of the cleft must be freshened so that union can take place.

3. This freshening must be done in such a way that the edge of the upper lip opposite the line of suture is made to project below the normal level of the lip. The object of this is to avoid the occurrence of a notch on the lip after the wound has shrunk when healing is complete.

4. The freshened edges of the cleft must be brought together and kept together.

To these fundamental principles James E. Thompson adds the following:

5. The red line of the lip must extend in a clean, unbroken curve from one side of the newly formed lip to the other.

6. The depth of the mucous membrane must be equal on each side of the line of suture.

7. The newly formed lip must not be too short, but must be lengthened so that it will more than cover the gums.

8. The nostril must be reproduced so as to have exactly the same dimensions as the sound nostril, and must consist of tissue of the same texture as the normal nostril.

9. There must be no flattening of the nose or ala nasi on the affected side."

SINGLE HARE-LIP

Incomplete Hare-lip.—The cleft in the lip does not extend into the nostril; it is often a mere notch. It may be unnecessary to relieve tension, though when the cleft is at all extensive or wide this is necessary and must be done thoroughly. Malgaigne's operation gives good results, but Nélaton's is the one usually recom-

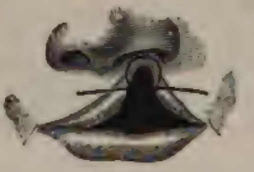


FIG. 165.

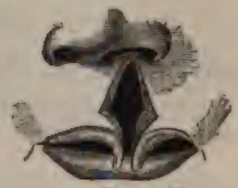


FIG. 166.

FIGS. 165 AND 166.—Malgaigne. (*Esmarch and Kowalzig.*)

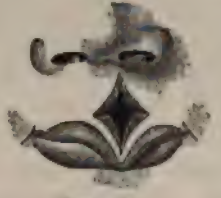


FIG. 167.

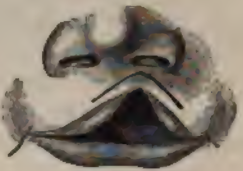


FIG. 168.

FIGS. 167 AND 168.—Nélaton. (*Esmarch and Kowalzig.*)

FIG. 169.

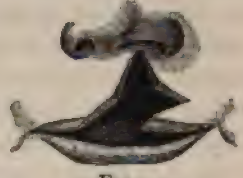


FIG. 170.

FIGS. 169 AND 170.—Mirault. (*Esmarch and Kowalzig.*)

FIG. 171.

FIG. 172.

FIGS. 171 AND 172.—C. H. Mayo's operation.

mended. These operations and a few others will be easily understood by a glance at Figs. 165 to 170.

In incomplete hare-lip, when the ala of the nose is pulled to the side and the nostril much widened, C. H. Mayo relieves tension very thoroughly, separating

the ala of the nose from its deep connections; then he makes his denudation at the floor of the nostril (Fig. 171, A, B), and by pulling the lip downwards and introducing sutures, converts the horizontal wound A, B into a vertical one (Fig. 172), The result is obliteration of the notch in the lip and correction of the deformed position of the ala of the nose.

Complete Single Hare-lip.—*Relief of Tension.*—This is one of the most important steps of all hare-lip operations. Failure to relieve tension completely is the most common cause of bad results.

The upper lip is everted and pulled upwards and outwards by the finger and thumb of the left hand (Fig. 173). The mucous membrane is incised at its reflection from gum to lip, and divided from the premolar region on one side to the premolar region on the other side, if necessary. Through this incision, with knife or scissors, one separates the soft parts from the bones (keeping the instrument close to the bone). Particular attention must be paid to the separation of the ala of the nose from the bone (Fig. 174).

FIG. 173.—Relief of tension.

FIG. 174.
The dotted area represents the extent of dissection that is commonly required for the relief of tension.

To what extent must the soft parts be separated from the bone? The answer to the foregoing question is until the edges of the cleft in the lip, when placed together, show a tendency to lie in apposition, so that the sutures when introduced may be tied without giving rise to tension.

Freshening of the Edges of the Cleft.—The methods of freshening the edges of the cleft are legion. Only one of the methods, viz., Collis,' will be described here.

The Collis Operation for Single Hare-lip.—Tension having been relieved, make the incision A, B (Fig. 175) along the line of junction between mucous membrane and skin. Dissect the mucous membrane, corresponding to that incision, from the subjacent tissues until the whole edge A, B of the cleft is raw. The mucous membrane may be entirely removed or may be left as a flap (F, Fig. 176) having its pedicle posteriorly. If the flap is left attached it forms, when the operation is completed, a sort of valve covering the posterior surface of the wound. In a few weeks no trace of it will be found.

On the external edge of the cleft make the incision C, E, D (Fig. 175) through the whole thickness of the lip. At the point E divide the flap thus formed by a horizontal incision. This results in the formation of two flaps, C e′ and D e (Figs. 175 and 176). Stitch the raw surface of the flap C e′ to the highest possible part of the raw surface A, B. This brings the ala of the nose into good position and provides an epithelial covered floor to the anterior nares. Turn the flap D e (Fig. 177) downwards and stitch it to the lowest possible part of the raw surface A, B. Stitch the point E (Fig. 177) to the

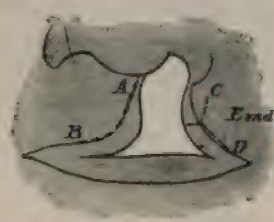


FIG. 175.

FIG. 176.

FIGS. 175 AND 176.—Collis' operation.

middle of the raw surface A, B. When all the sutures are in place and tied, the wound line will appear as represented in Fig. 177.

This operation wastes no valuable tissue and gives a particularly long upper lip. Figs. 178 to 186 suffice to illustrate some other well-known methods of operating.

Sutures.—One or two deep sutures involving almost the whole thickness of the lip must be inserted. The best material for these is silkworm-gut. Hare-lip pins have been discarded, as they cause too much scarring. Usually the deep sutures are inserted through the skin and give rise to considerable scarring at their points of entrance and emergence; a better plan is to introduce the *deep* sutures from the mucous surface and *not* to involve the skin in their bite; when this is done, these stitches must not be removed until healing is complete, when they will generally be found to have cut their own way out. If the surgeon endeavors to remove such sutures at the end of a week, he requires to evert the lip, and thus jeopardizes the line of union. Several superficial cutaneous sutures must be introduced; the best material for these is horse-hair. Horse-hair sutures, because of their elasticity, leave less scar than any others. All cutaneous sutures (superficial and deep) may be removed by the seventh day.

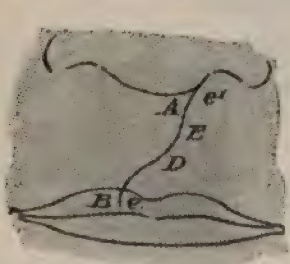


FIG. 177.—Collis' operation.

DOUBLE UNCOMPLICATED HARE-LIP

When the deformity is not complicated by the central portion of the lip being carried forwards towards the tip of the nose by the intermaxillary bone, the following operation will generally be found satisfactory.

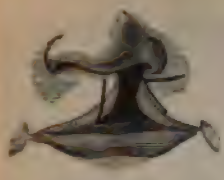


FIG. 178.

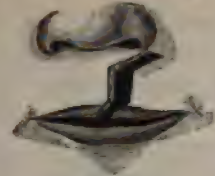


FIG. 179.

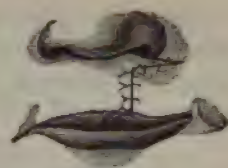


FIG. 180.

FIGS. 178, 179 AND 180.—Giraldes. (*Esmarch and Kowalzig.*)

FIG. 181.

FIG. 182.

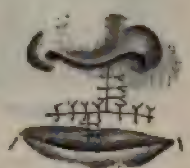


FIG. 183.

FIGS. 181, 182 AND 183.—König. (*Esmarch and Kowalzig.*)

FIG. 184.

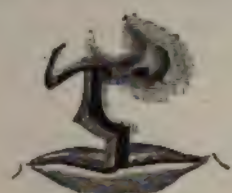


FIG. 185.

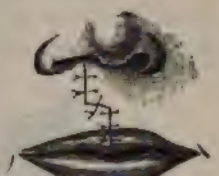


FIG. 186.

FIGS. 184, 185 AND 186.—König. (*Esmarch and Kowalzig.*)

FIG. 187.

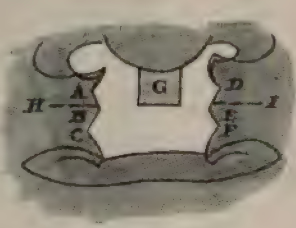


FIG. 188.

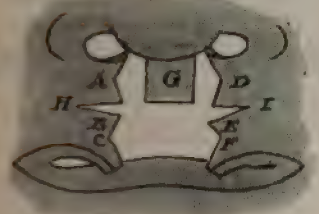


FIG. 189.

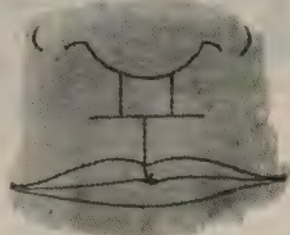


FIG. 190.

Make the incisions A, B, C and D, E, F (Fig. 187) through the whole thickness of the lip. At the points B and E divide each of the flaps thus formed into two. The edges of the central portion of the lip (Figs. 187, 188, 189 G) are now to be pared. On each side there are now two flaps, an upper and a lower.


Fig. 191.


Fig. 192.


Fig. 193.

Figs. 191, 192 and 193.—Maas. (*Esmarch and Kowalzig.*)

The raw surfaces of the upper flaps are to be sutured to the lateral raw surfaces of G as high up as possible. Corresponding to the lower edge of G, the horizontal incisions H and I (Figs. 188 and 189) must be made through the whole thickness of the lip on each side. This procedure permits the easy approxima-


Fig. 194.


Fig. 195.

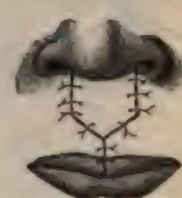


Fig. 196.

Figs. 194, 195 and 196.—Hagedorn. (*Esmarch and Kowalzig.*)

tion of the edges of the cleft below the level of the central part (G). The two lower flaps when their raw surfaces are sutured together form a prominence on the edge of the new upper lip. The appearance of the wound when the opera-

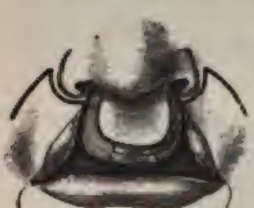


Fig. 197.

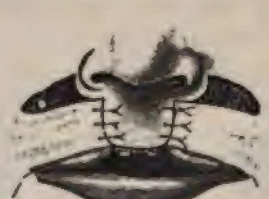


Fig. 198.


Fig. 199.

Figs. 197, 198 and 199.—Simon. (*Esmarch and Kowalzig.*)

tion is completed is represented in Fig. 190. Other methods of operating are sufficiently illustrated by Figs. 191 to 199.

James E. Thompson ("Surg., Gyn., Obst.," May, 1912) good naturedly laughs at many of the operations for hare-lip figured in this and other books

giving diagrams representing what the true results must be, alongside the time-honored figures showing the results as imagined by the inventors of the operations. To insure accuracy in making his incisions, Thompson uses sharp-

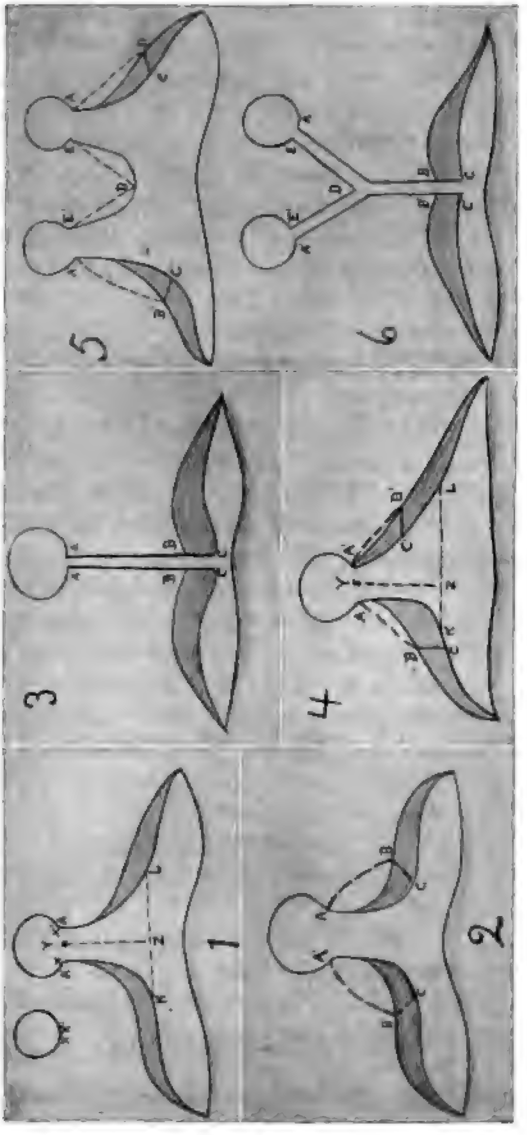


FIG. 200.—(*Thompson.*)

pointed compasses which can be fixed by a screw and with them makes all necessary measurements and marks.

Thompson's Methods.—I. Single complete hare-lip without much divergence of the sides of the cleft. At A and A′, Fig. 200, 1, a projection or shoulder shows the junction of the cleft and the nasal margin. With compasses measure the

distance from Y (midway between A and A′) to Z placed on an imaginary line KL which represents the natural curve of the upper lip. Fix the compasses so that their points will remain this distance (YZ) apart. Place one point of the compasses at A and the other at B on the *skin* of the lip close to the red line of the mucous membrane. Mark the point B, Fig. 200, 2, by pricking the skin. In the same fashion find and mark the point B′. The line AB equals in length the line A′B′. Readjust the compasses and take the measurement BC, the point C being on the free margin of the lip. The angle ABC is usually about 60° and must always be less than 90° if a projecting prolabium is to result from the completed operation. Mark the point C by pricking the mucosa. In the same fashion find and mark the point C′. The line BC equals in length the line B′C′. Pass a retaining stitch of horse-hair "through each side of the mucous membrane of the lip close to, but below, C and C′." Suture A to A′, B to B′, C to C′, Fig. 200, 3.

II. The sides of the cleft are unsymmetrical. Fig. 200, 4, shows how the same operation gives the same results provided that the cheeks have been well mobilized as advised on p. 135.

III. Double hare-lip. In Figs. 200, 5, and 200, 6," the shoulders marking the margins of the nostrils are shown at A and E, and at A′ and E′. The triangle E′DE shows the line of incision by which the central piece of skin covering the intermaxillary bone is pared. E and E′ are placed on the inner margins of the nostrils. The sides DE and DE′ are usually equal in length to one another and their length varies according to the depth of the central piece of skin. It must never be greater than AB and is usually much less. The points A, B and C and A′, B′ and C′ are chosen as described previously in the operation on single hare-lip. Fig. 200, 6, shows the final appearance of the lip when the flaps have been cut and the parts approximated. The point A is in contact with E, A′ and E′; the apex D of the triangle E′DE lies somewhere along the line AB; the point B is in contact with B′, and C with C′.

Two essential points must be emphasized:

1. Under no circumstances must the circumference of the nostril be encroached upon. The shoulders that represent the margins of the nostril must be accurately approximated.

2. The points B and B′ must be as close to the red line of the lip as possible, and must always be on the skin (upper side) of this line."

COMPLICATED HARE-LIP

A. Single complete hare-lip. The alveolus is cleft and one side of the cleft is much more prominent than the other. If possible push the protruding part into alignment with the rest of the alveolus. If this is not possible introduce a mattress suture of wire as shown in Fig. 201, divide the bone at A, push the mobilized bone into proper position and fasten it with the wire.

B. Double hare-lip complicated by the presence of the intermaxillary bone hanging at the tip of the nose.

Some surgeons advise that the misplaced intermaxillary bone be entirely removed. When this has been done, it is very difficult to secure union between the new-formed upper lip and the column of the nose. Undoubtedly it is wise to retain the bone and replace it in its proper position. An incision (Fig. 202) is made through the muco-periosteum of the nasal septum, beginning immediately behind the intermaxillary bone and extending backwards for 3/4 of an inch. A fine periosteal elevator or probe is passed through this incision and the muco-periosteum raised on each side of the septum (Figs. 203 and 204) from its edge up to the root of the nose. With a strong pair of scissors a triangular piece of the septum (Fig. 203) is now excised. This permits the intermaxillary bone to be easily pushed back into position. It is not absolutely necessary to trim off the mucous membrane covering the intermaxillary bone and those portions of the superior maxilla with which it is in contact, though it is advisable to do so, as union can then take place with rapidity. If any developing teeth are encountered, remove such. Teeth which appear later in bad position are to be treated by a dentist. Suture of the bone in position is unnecessary. The cleft in the lip should be united at the same sitting.

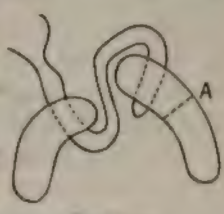


FIG. 201.

Sometimes instead of excising a wedge from the septum it is sufficient to make a vertical cut through it and slide that portion of the septum anterior to the cut back alongside the posterior portion (Fig. 204). Lane thoroughly disapproves of all these attempts to replace the intermaxillary bone.


FIG. 202. (*Esmarch and Kowalzig.*)


FIG. 203. (*Esmarch and Kowalzig.*)


FIG. 204. (*Esmarch and Kowalzig.*)

If the intermaxillary bone has been dislocated backwards by any of the means described, Reich ("Zent. für Chir.," 1911, No. 25) remarks that it forms "a blunt and bull-dog nose." He has endeavored to overcome this error.

Reich's Operation. Step 1.—Dissect the philtrum from the intermaxillary bone and, in doing so, expose the edge of the cartilaginous septum immediately above the intermaxillary bone. With straight scissors divide the nasal septum obliquely upwards and backwards as high as possible (Fig. 205). This cut divides the mucosa, periosteum and perichondrium, cartilaginous septum and

the perpendicular plate of the ethmoid and leaves in front of it, and separate from the rest of the septum, a plate of bone and cartilage reaching from the root to the tip of the nose, guaranteeing its profile.

Step 2.—Subperiosteally excise a wedge of the septum as in the preceding operation but much farther back. Push the intermaxillary bone into correct position.

Step 3.—Close the hare-lip in the usual manner, using the philtrum nasi to form the cutaneous septum of the nose (Fig. 206).

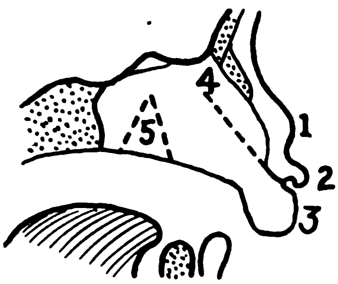


FIG. 205.

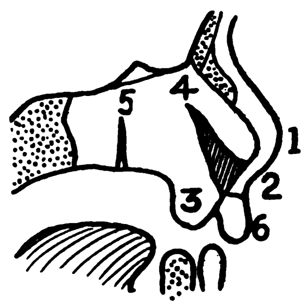


FIG. 206.

FIGS. 205 AND 206.—1. Point of Nose. 2. Philtrum of nose. 3. Intermaxillary bone. 4. Oblique section of septum. 5. Wedge of septum removed.

DRESSINGS AFTER OPERATIONS FOR HARE-LIP

Should tension on the sutures be feared, a strip of adhesive plaster may be placed from cheek to cheek across the upper lip, in such a way as to relieve tension. If, however, the soft parts of the lip and cheeks have been sufficiently separated from the bones at the beginning of the operation, then such a measure is unnecessary and undesirable, as it simply irritates the already irritable patient. It is not necessary to apply any dressing to the wound, as nature soon seals it with dried blood-clot. Until the sutures are removed there should be as little interference with the wound as possible. If it is going to heal, it will heal under the scab, and the best-intentioned endeavors to clean the wound will merely interfere with nature's work and do no good, as cleanliness can never be attained in such cases. Care must be taken so to fix the little patient's arms that scratching of the wound is rendered impossible.

When it is desired to close the cleft in the palate, which almost invariably accompanies extensive hare-lip, such closure ought to be effected either at the same time as the intermaxillary bone is replaced or at a former operation.

CHAPTER XV

CLEFT PALATE

proper time to operate for cleft palate is when the patient is under onths of age; the best method of operating is inapplicable in children six months. Brophy has operated on 211 cases of cleft palate in babies than six months without a single death, yet the operation is unlly not without risk. The operation should be performed before the of the concomitant hare-lip. Brophy gives the following reasons for ve practice: (1) The existence of the hare-lip gives more room in which k. (2) There is less nervous shock after an operation on a child of a eeks of age than when the babe is older. (3) The are soft. (4) After operation the child will be nourished. (5) The muscles of the palate are given pportunity to develop instead of atrophy, and the nt does not get into the habit of articulating through avern of the nose.

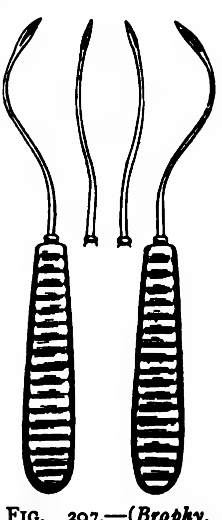


FIG. 207.—(*Brophy*, "*Dental Cosmos.*")

Before operating see that the patient's general health ood and that no local conditions exist which might rfere with repair. If adenoids are present, they must emoved. For a few days prior to operation it is well leanse the mouth and nasal cavity with a saturated ion of boracic acid in glycerin.

rophy's Operation.—Applicable in children younger three months; generally possible, though not so easy, dren up to, but not beyond, the sixth month. The pecial instruments required are two of Brophy's needles (Fig. 207); a few strands of No. 20 silver nd plates No. 17, American gage. No special ag is necessary, the assistant's fingers being sufficient to keep the pen and the tongue depressed. Immediately before operating the wabs the parts with adrenalin solution. This lessens hemorrhage. peration bleeding is easily controlled by pressure with pledgets of ung out of hot water.

Operation.—1. Anesthetize the patient. Place in Rose's or the Tren- position. Pass a stout thread through the anterior end of the a traction suture. This is a great convenience.

th a knife pare thoroughly the edges of the cleft in the hard palate, away a little of the bone itself to insure thoroughness. Either pare or ally split the edges of the cl soft palate. If split thoroughly,

the edges of the split retract and so a good raw surface is left without any loss of tissue.

3. Thread a Brophy needle with strong silk or celluloid hemp. Raise the cheek and pass the threaded needle through the superior maxilla from without inwards at a point just back of the malar process and high enough to be ***above*** the palate (Fig. 208). When the needle appears in the cleft, pick up the thread, which it carries, with hook or forceps. Withdraw the needle, leaving the loop of thread *in situ*. Catch the ends of the thread in a hemostat. Through a corresponding part of the opposite bone pass a loop of thread in the same manner. Pass this second loop of thread through the first and pull the latter out, carrying with it the former. We now have a loop of thread passing through both superior maxillary bones above the palate, and when necessary through the nasal septum. By means of this thread pull a strand of very strong silver wire through the same track.

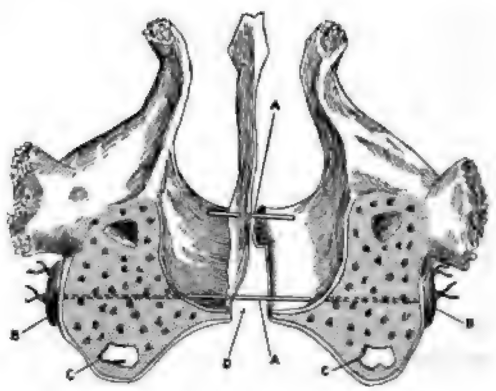


FIG. 208.—(*Brophy, "Dental Cosmos."*)

4. In the same manner introduce one or sometimes two other silver wires through the anterior portion of the maxilla above the level of the palate (Fig. 208, A).

5. Pass the ends of the silver wire through holes in lead plates moulded to fit the convexity of the buccal surfaces of the bones (one plate on each side). Draw the wires tight and twist them together—*i.e.*, twist the "right end of the anterior wire to the right end of the posterior wire and the same on the left side" (B, Fig. 208).

6. With the thumbs forcibly press the two maxillary bones together until the cleft is completely closed. Twist the wires once more so as to hold the bones firmly together.

7. Close the soft palate by sutures. The state of the patient may necessitate this step being delayed until another day. Do not close the hare-lip until the palate is completely closed and the patient has recovered.

Note.—If closure of the cleft by mere compression proves impossible, division of the malar process may be practised. Make a very small incision through the mucous membrane over the malar process of the superior maxilla. Through this divide the process

orizontally, *i.e.*, parallel to the alveolar edge, either with a knife or a small chisel, such as entists use.

After-treatment consists in as great cleanliness of mouth and nose as can be ttained; in the use of stimulants, if necessary; and in feeding by means of a poon. The plates and wire sutures remain in place from two to four weeks.

In unilateral cleft palate the palatal process of one side has united with the eptum of the nose. In such cases the septum is often very much curved, and ts lower portion seems a continuation of the palatal process to which it is united. If, in the course of operation, it is difficult to bring the edges of the two palatal rocesses together, we may cut a groove in the septum at he point X (Fig. 209) and bring the freshened edge of the nunited palatal process (P′, Fig. 209) into apposition with t, thus using a part of the septum to close the defect.

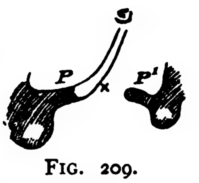


FIG. 209.

Uranoplasty (Arbuthnot Lane's Operation).—For many easons the operation should be performed as early as possible after birth. Before the milk teeth erupt there is plenty f material present to permit the closure of almost any defect no matter how ride it may be. The large surfaces of bare bone left after Lane's operation eal very rapidly.

Instruments required:

1. Lane's mouth gags with sharp teeth which bite into the gums. These re sold in pairs of proper sizes (Figs. 210 and 211).

2. Lane's needle holder with very small needles (Figs. 212 and 213). This as originally devised for suture of the bile ducts.

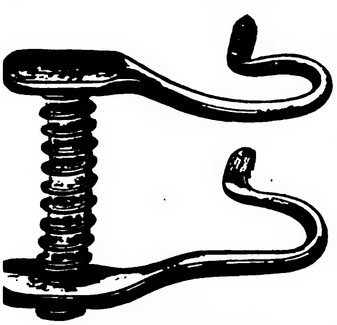


FIG. 210.—(*Lane*.)

3. One small strong knife. A Jones' tenotome will serve admirably.

4. Fine sharp-pointed scissors.

5. One strong hemostat with mouse teeth at the point.

6. Fine strong silk or hemp.

7. A good mouse-tooth dissecting forceps suitable for catching the tissues or the end of a needle.

Type A.—The cleft in the hard palate is unilateral. The septum is continuous with the hard palate on one side. The alveolus and the ft palate are also cleft.

***Step* 1.**—Formation of reflected flap. Make the incision 7, 5, 6, 8 through e muco-periosteum to the bone (Fig. 214). In order to obtain plenty of tissue at part of the incision represented by the line from 5 to 6 is made on the outer rface of the alveolus near the reflection of the mucosa from the alveolus to the eek. Make the incision through the mucosa of the soft palate, but do *not* jure the musculature. Reflect the outlined flap 7, 5, 6, 8. The pedicle or ge of the flap corresponds to the edge of the cleft in the palate.

In separating the muco-periosteum from the bone as the posterior palatine

foramen is approached, an elevator pressed in between the flap and the bony palate causes the posterior palatine vessels and nerves to protrude for a considerable length in a tube of periosteum. This is readily grasped by an efficient hemostat, which is left in place until hemostasis is assured.

That portion of the flap taken from the soft palate consists of mucosa and submucosa. It is important not to injure the muscles of the palate. The reflected flap is formed on the side of the cleft which is *not* attached to the septum.

FIG. 211.—(*Lane.*)

Step 2.—On the side of the cleft attached to the septum proceed as follows: With forceps pull the uvula and soft palate forwards so as to expose its nasal surface. Divide the mucosa along the posterior edge of the soft palate (4, 3, Fig. 214). Continue the incision across the nasal surface of the soft palate to the point where the soft and hard palates meet at the edge of the cleft (3, 2, Fig. 214). Continue the incision forwards along the edge of the hard palate (2, 1) and across the alveolus (1, 9). The part of the incision affecting the hard palate and the alveolus penetrates the whole thickness of the muco-periosteum. The

the incision affecting the soft palate only penetrates the mucosa and osa. Reflect the mucous flap (2, 3, 4) outlined on the nasal surface of : palate. Introduce an elevator through the incision 9, 1, 2 (Fig. 214) arate the muco-periosteum from the hard palate and to a slight extent ie alveolus near the point 9. Divide the attachments soft palate to the hard palate along the posterior edge latter, leaving intact the mucosa on the oral side of ate. During Step 2 the posterior palatine artery re- ininjured.

3.—**Turn the flap 5, 7, 8, 6 so that its epithelial- l surface is directed towards the nose and its raw sur- wards the mouth.** Tuck the edge of flap 5, 7, 8, 6 der flap 9, 1, 2, 3, 4, and fix it in position by two rows sutures (Figs. 215 and 216).

e B.—The cleft is wide; the septum is not attached palate; the alveolus is not cleft.

1.—**Make the flap 1, 2, 3** (Fig. 217) as in Type A.

2.—**On the opposite side make the incision 6 through co-periosteum along the edge of the cleft.** Make the 7 and 8 on the nasal surface of the soft palate and a flap of mucosa from the soft palate as in Type A. te the muco-periosteum from the hard palate and di- e attachments of the soft to the hard palate along the or edge of the latter, leaving intact the mucous mem- n the oral surface.

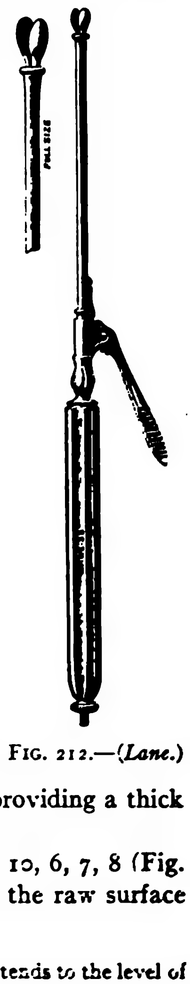


FIG. 212.—(*Lane.*)

3.—**Turn flap 1, 2, 3 over, with its epithelial surface d towards the nasal cavity, so as to cover the cleft.** he free edge of this flap well under the flap 10, 6, 7, 8. iangular portion of this latter flap which was obtained he nasal surface of the soft palate assists greatly in providing a thick lum palati.

4.—**Suture the edge of flap 1, 2, 3 to the base of flap 10, 6, 7, 8** (Fig. 218). **Suture the edge of flap of 10, 6, 7, 8 to the raw surface of flap 1, 2, 3** (Fig. 218).

Note.—If the lower or free edge of the nasal septum extends to the level of the cleft, attach it to flap 1, 2 and 3 in the following manner after completing step 2 as described: Make an incision (4, Fig. 217) through the mucosa and periosteum or perichondrium along the middle line of the septum with two small transverse incisions (5) at either end, and turn down laterally the narrow flaps so formed, leaving the cartilage or bone bared and exposed. By placing flap 1, 2, 3 in correct position, the line along which it [illegible] rest on the septal [illegible] can be readily defined. Along the line of contact [illegible] 3 with a sharp knife. By a series of sutures [illegible] if it be not too hard [illegible] flap to the septum [illegible] Proceed to

Type C.—Double cleft palate. Premaxillary bone (P, M, Fig. 219) well in front of the alveolar arch and fixed to the under surface of the nose; the mesial

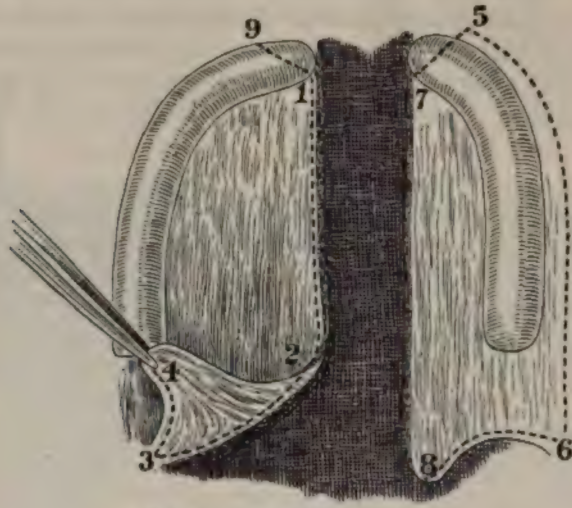


FIG. 214.—Lane's uranoplasty.

segment (L) of lip is fixed to the anterior surface of the premaxilla. Operation by means of reflected and pivoting flaps. (The following description is in Lane's own words.)

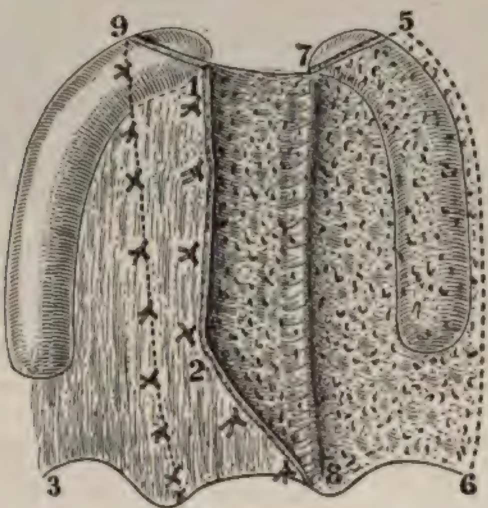


FIG. 215.—Lane's uranoplasty.

"The reflected flap is obtained by an incision extending from 1 along the outer aspect of the alveolus, through 2, and on to 3, when it bends inwards along the free margin of the soft palate to the uvula 4. The pivoting flap is obtained

ι incision from 5, along the outer aspect of the alveolus, through 6, along ıargin of the cleft in the hard palate from 7 to 8, along the upper surface e soft palate 9, and then to 10.

The area of mucous membrane corresponding to the triangle 8, 9 and 10, ised and reflected inwards. The area of muco-periosteum included in 7 and 8 is raised from the subjacent bone, except at the point of entry of posterior palatine vessels and nerves, which form the pivot on which this

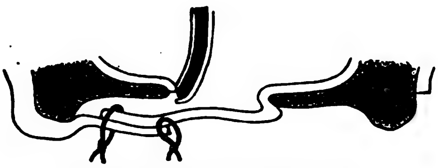


FIG. 216.—Lane's uranoplasty.

rotates. The mucous membrane is stripped from the premaxilla and from free edge of the septum in the manner indicated by the dotted lines, showing ions in the diagram.

Large flaps are cut from the portions of lip forming the edges of the cleft, great care is taken that they have an extensive attachment at their bases.

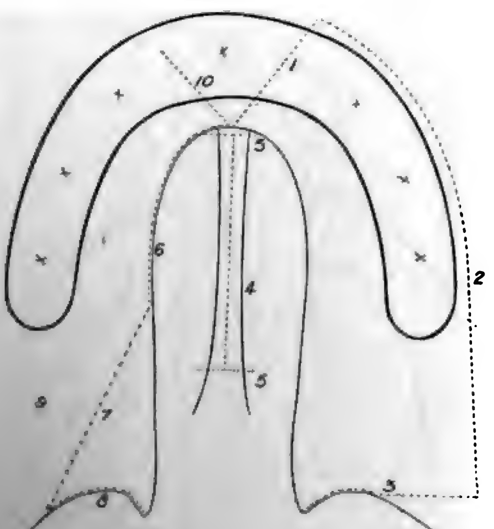


FIG. 217.—(*Lane.*)

nucous membrane covering the lateral and lower aspects of the piece of ng in the front of the premaxilla is removed (L).

The reflected flap is first put in position; the mucous membrane, where it into contact with the under surface of the septum, having been rendered s secured to it by sutures. The pivoting flap is then moved inwards upon

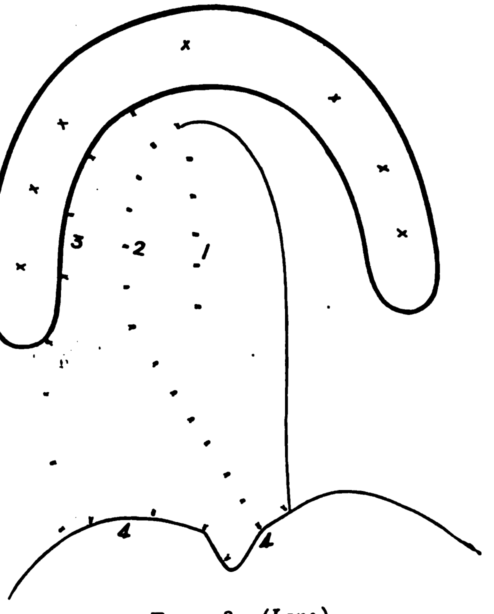


FIG. 218.—(*Lane.*)

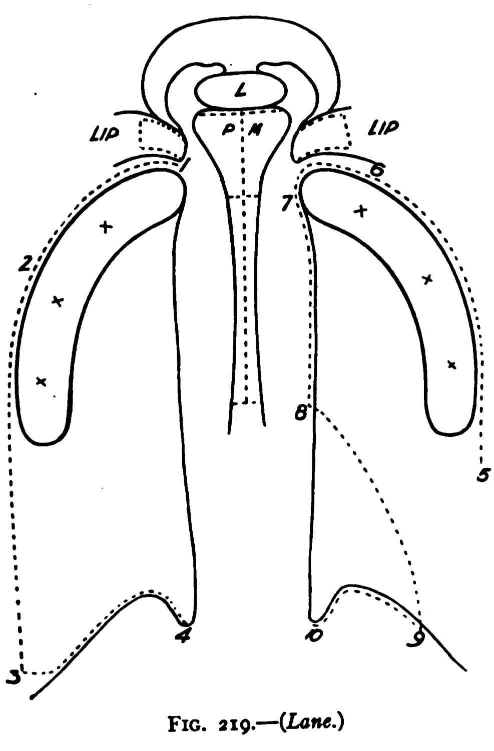


FIG. 219.—(*Lane.*)

eflected flap, to which it is united firmly by a double row of sutures. Finally oft palate is closed in a similar manner. This is represented in Fig. 220.

After this the triangular areas of muco-periosteum which were reflected the premaxilla are fixed in position (see Fig. 223), where these are indicated . The flaps from the lips shown as F, F are arranged with their raw surs upwards. These are united to the raw surfaces of the flaps from the naxilla and of the reflected flap, and are also sutured by their margins to another and to the free edge of the pivoting flap (see Fig. 221).

'Lastly, the ala of the nose is cut away from the cheek on either side and is laced inwards where it is united by sutures to the septum, and is sewn to cheek in its new position. This I have attempted to indicate in the same

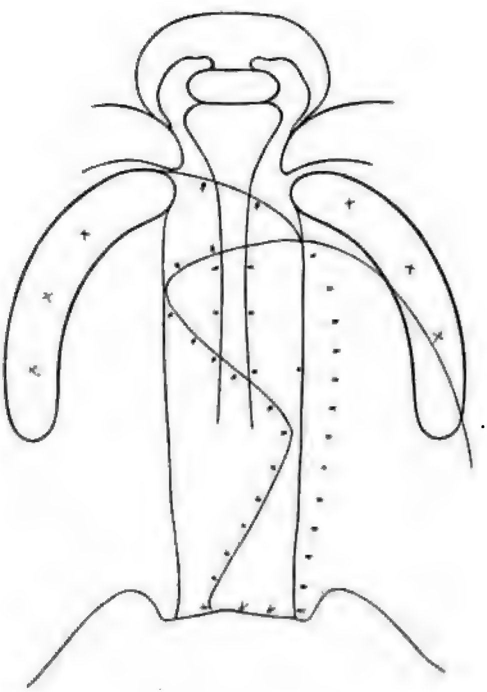


FIG. 220.—(*Lane.*)

ram. Having brought the edges of the lip into accurate position by ns of separate sutures, two sutures of linen thread are passed in the manner cated in Fig. 222. The needle perforates the lip from behind, and is le to re-enter the anterior aspect of the lip through the same hole, and after versing the lip transversely it again emerges and enters through the same , the needle passing directly backwards through the lip. When this thread made taut and tied the opposing raw surfaces of lip are held in accurate ition, and no scar whatever results from the presence of these deep sutures, ich can be readily removed when they have served their purpose. In Fig. only one cleft in the lip is represented."

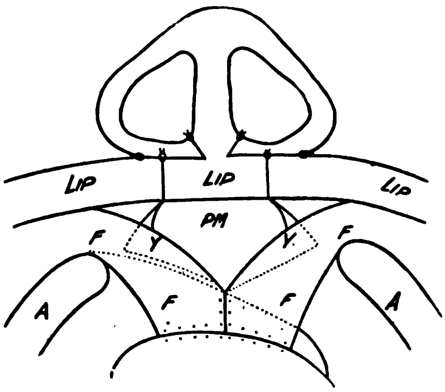


FIG. 221.—(*Lane.*)

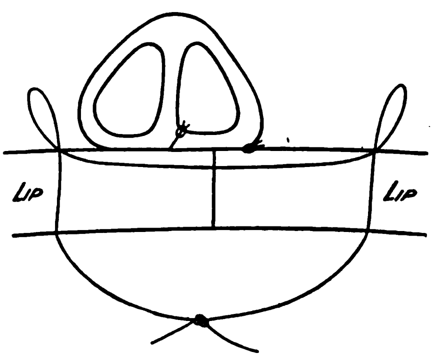


FIG. 222.—(*Lane.*)

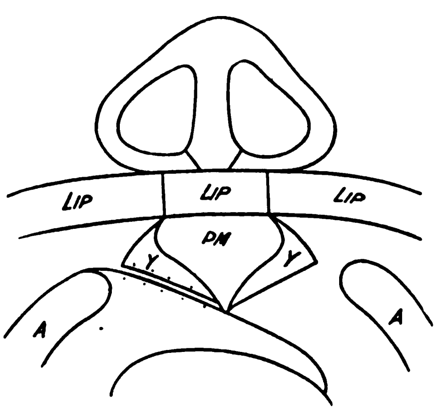


FIG. 223.—(*Lane.*)

Type D.—Wide cleft of soft palate.

Step 1.—Reflect the flap 1, 5, 6, 7, 8 (Fig. 224) with its base at the edge of e cleft.

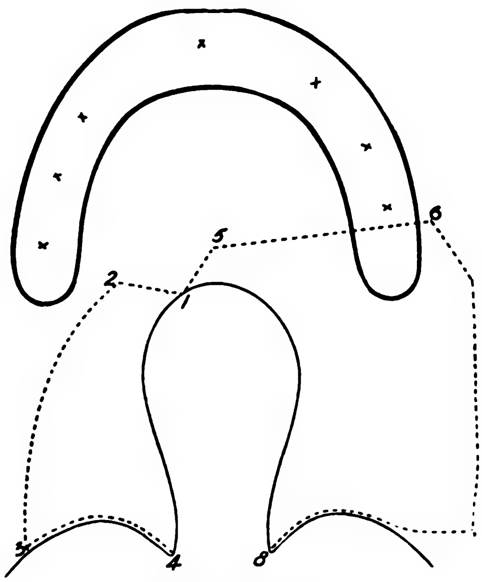


FIG. 224.—(*Lane.*)

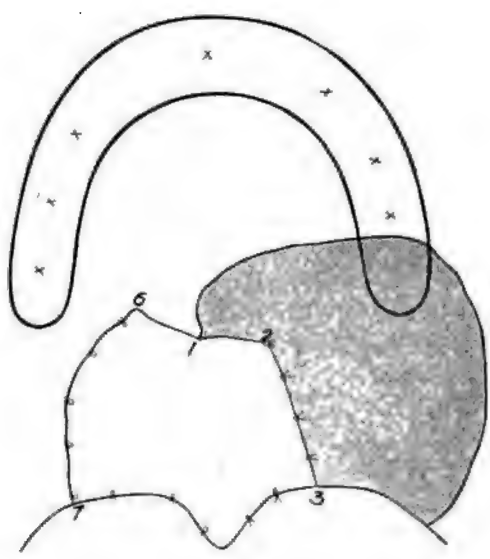


FIG. 225.—(*Lane.*)

The flap consists partly of muco-periosteum from the hard palate and lveolus and mostly of mucous membrane from the soft palate and cheek.

The flap must be large enough to easily cover the defect. Do not injure the musculature of the soft palate.

Step 2.—From the *nasal* surface of the soft palate on the opposite side of the cleft reflect the flap 1, 2, 3, 4 with its base at the edge of the cleft.

Step 3.—Suture the two flaps together one over the other in an overlapping fashion (Fig. 225).

After the milk teeth have erupted some modification of Lane's methods or the following classical operation may be selected.

The patient having been anesthetized, placed in Rose's position, and a traction thread passed through the tongue, a suitable gag is introduced. Of

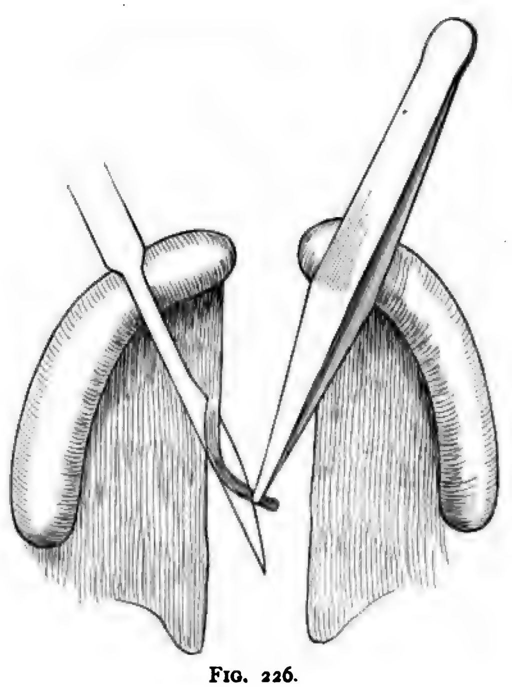


FIG. 226.

the numerous gags invented, probably Lane's or Whitehead's is the best, but the writer finds that a piece of wood about ¾ inch thick answers every purpose, and consequently rarely uses anything else.

1. *Denudation.*—Seize the end of the vulva on one side with a sharp hook or forceps (Fig. 226). With a sharp knife or tenotome remove a strip of mucous membrane from the whole edge of the cleft. In cutting, do so obliquely, removing rather more membrane from the oral than from the nasal side of the palate. This gives a more extensive raw surface, which is a great advantage. When the soft palate is very thick, its edge may be split instead of pared. Repeat the process on the other side of the cleft.

2. With a suitable periosteotome or knife divide the muco-periosteum along the edge of the cleft in the hard palate. Separate all the muco-periosteum

e hard palate up to the alveolar process (Fig. 227). For this procedure 's periosteotomes (Fig. 228) are convenient, but a suitable instrument ' extemporized from a dental spatula or even an aneurysm needle.

. 227.

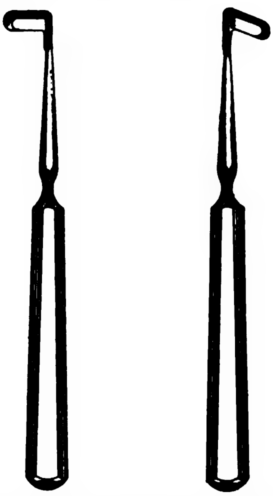


FIG. 228.—(*Brophy*, "*Dental Cosmos.*")

3. The soft palate may be said to consist of three layers: (*a*) The nasal mucous membrane; (*b*) the tissues attached to the posterior edge of the hard palate; (*c*) the oral mucous membrane.

Leaving intact the oral mucous membrane, which is continuous from hard to soft palate, divide trans- ' with fine curved scissors both the nasal mucous :ane and the tissues attached to the posterior of the hard palate. This is one of the most :ant steps in the operation, allowing the muco- :eal flap obtained from the hard palate to drop ls the mouth, and with it the soft palate (Figs. d 232). Repeat this procedure on the opposite Commonly the raw edges of the flaps thus ed will come into apposition without tension. r do not, it is necessary to make a lateral incision through the muco-peri- ı parallel and close to the alveolus (Fig. 230) on one or both sides of the , and extending from the lateral incisor back to the posterior margin of the

IG. 229.

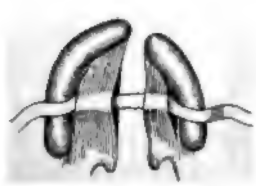


FIG. 230.

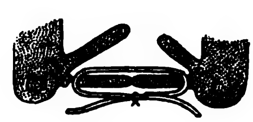


FIG. 231.

alate. If this is insufficient to relieve tension, Billroth's procedure may be d as follows: Pass a fine chisel through the posterior angle of the lateral ı; direct it obliquely inwards and upwards against the hamular process,

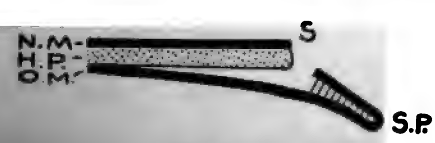


FIG. 232.

al mucosa. H. P. Hard palate. O. M. Oral mucosa. S. P. Soft palate. S. Line of section.

th a light blow from the hand make it divide that bone. The dislocation hamular process, increased if necessary by the use of an elevator, gives relaxation of the velum palati and does not injure its musculature.

Incisions through the soft palate dividing its muscles were formerly considered necessary; *now they are never admissible.*

C. H. Mayo considers it important to make lateral incisions (Fig. 230) on both sides, not merely to relieve tension, but to permit the use of a relaxation tape. Having prepared the parts for the insertion of sutures, and having made two lateral incisions close to the alveoli, he introduces a narrow tape

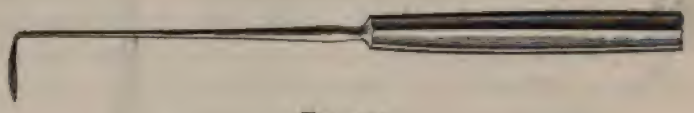


FIG. 233.

which surrounds the right and left muco-periosteal flaps (Fig. 230). Traction on the ends of the tape brings the flaps towards the operator, steadies them, and facilitates the introduction of the ordinary sutures. When the sutures are in place and tied, Mayo crosses the free ends of the tape and fixes them by tying a ligature around them at this point (Fig. 231), cuts off the superfluous portions of the tape, and lastly slides the whole tape until that part fastened by the ligature lies in the nasal instead of in the oral cavity. The tape fastened as

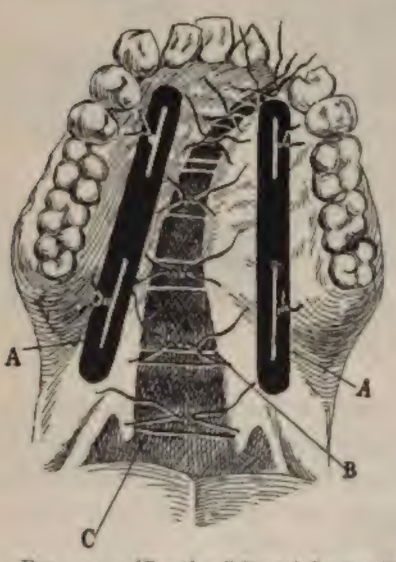


FIG. 234.—(*Brophy, "Dental Cosmos."*)

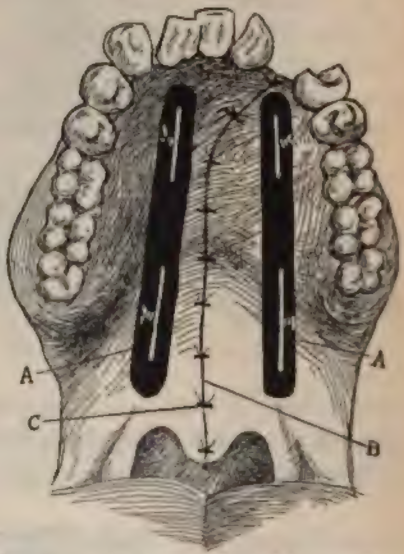


FIG. 235.—(*Brophy, "Dental Cosmos."*)

above acts as an efficient relaxation suture or support; it also drains secretions from the nasal cavity into the mouth. It is remarkable how this very simple contrivance facilitates the operation.

4. Suture. Many special needles have been devised to overcome the difficulties met with in closing palatal defects. Of these, the Deschamps (Fig. 233) is perhaps the best, although it is usually made too large. The

finds that he can discard such special instrument by using very small, ·ved needles, grasped in a long-necked needle-holder, and passing each end thread, armed with a needle, from the nasal to the oral side of the palate, om within outwards. The usual method of suturing is to begin at ula and work forwards, being careful to *evert* the edges of the wound when ıps from the hard palate are being united. Silk or celluloid hemp are aterials used.

ophy puts in, as a preliminary, tension sutures of No. 22 silver wire, these on lead plates (Figs. 234 and 235). He claims that the use of obviates the necessity of lateral incisions, and that the lead plates act as int, securing rest, and hence better results. The fact that numbers of hy's cases have passed the supreme test of successfully reading aloud be- professional societies makes his opinions and procedures worthy of the est consideration. C. H. Peck recommends the use of a dental plate to ct the united palate. The plate must of course be removed frequently he sake of cleanliness.

FIG. 236.

Q. Line of separation of attachments of velum to hard palate. X, Y, Z, Q. Area in which muco-periosteum (continuous with the velum) is separated from the bone.

fter-treatment.—Liquid or soft food is alone permissible. Antiseptic ys may be used if not annoying to the patient. The patient should get out ed and, in suitable weather, out of doors as soon as possible. The sutures t not be removed earlier than the seventh day after operation.

Partial Cleft Palate.—When there is a cleft of the soft palate alone and edges can be brought together without tension, one is content to pare the es and apply sutures. When the cleft in the soft palate reaches close to the d or when the latter is partially cleft, it is absolutely necessary to relieve sion. This is done in the same fashion as in complete cleft palate by di- ing the attachments of the velum to the hard palate and by separating the co-periosteum from the bone to as great an extent as may be necessary g. 236).

CHAPTER XVI

TONGUE

Butlin's Marginal Resection of the Tongue.—This operation is suitable where the tongue is originally, or has become, too large for the mouth and where its lateral margin in contact with the teeth shows dangerous or annoying irritability. The effects of the operation are: (*a*) diminution in the size of the tongue without impairment of mobility or speech, (*b*) the teeth, instead of being in contact with an irritable papilla-bearing surface, now lie in contact with smooth mucous membrane derived from the inframarginal surface of the tongue.

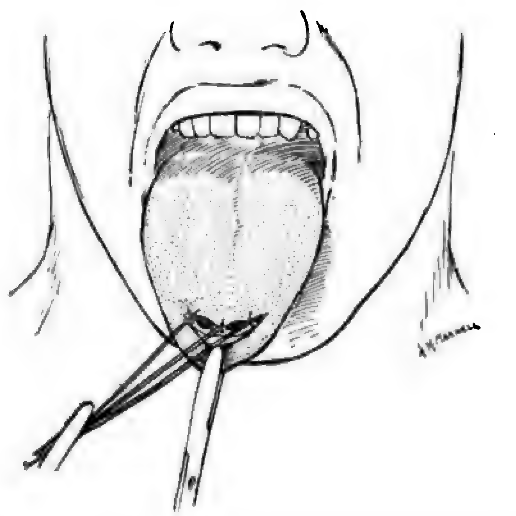


FIG. 237.—First stage of operation. (By permission from the *British Journal of Surgery.*)

Butlin's operation (Burghard's Op. Surg. II, 209) has been modified by Sampson Handley (Brit. Journ. Surg. I, 42) so as to do away with the necessity of laryngotomy.

An anesthetic should be administered exactly as in operating for cleft palate.

Step 1.—Transfix the tongue far back by a strong silk suture for purposes of traction and control. Seize the tip of the tongue with a volsellum and pull it forwards.

Step 2.—On the dorsum make a more or less transverse incision parallel to the end of the tongue and about 1½ inches long. On the undersurface of the tongue make a corresponding incision. Through these two incisions cut out a wedge-shaped segment of the tongue but leave (Fig. 237) the segment attached by its two ends to the tongue.

tep 3.—Pulling the mobilized segment away from the tongue, close the ;e-shaped wound with sutures. This stops bleeding.

'tep 4.—Step by step continue the wedge-shaped excision along the edge ıe tongue and apply sutures to stop bleeding. When the level of the last ır tooth is reached finish the dissection on that side (Fig. 238). In similar ion resect the opposite side of the tongue.

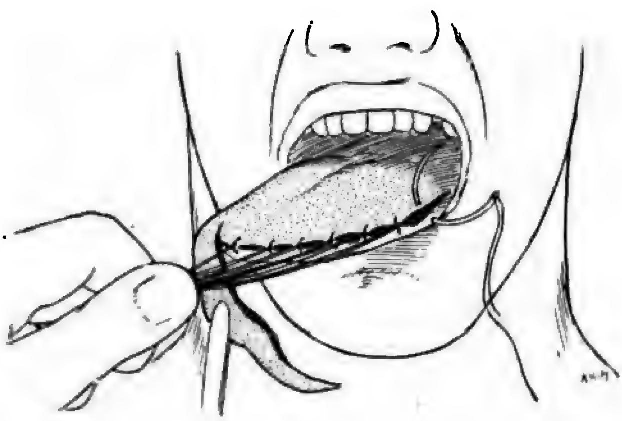
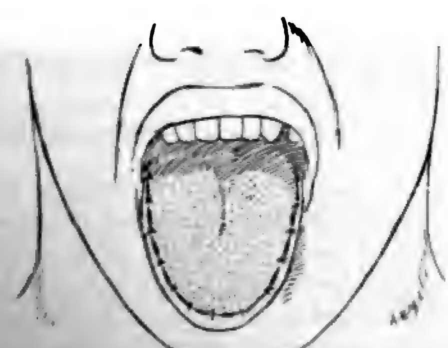


FIG. 238.—Second stage. (By permission from the *British Journal of Surgery.*)

The lower incision should be at the junction of the smooth mucosa of the lersurface of the tongue with the papillary mucosa of the dorsum. The sal incision must be made internal to the tissue it is desired to excise. e smooth infralingual mucosa being preserved makes an excellent flap for reconstruction of the margins of the tongue (Fig. 239).



. 239.—The operation completed. (By permission from the *British Journal of Surgery.*)

When a small tumor exists near the tip of the tongue, it may be removed means of a V-shaped incision.

Dieffenbach's Operation.—Local anesthesia usually suffices. If a general esthetic is used, the mouth must be kept open during the operation by a outh-gag. Pull the tongue forwards by means of a volsellum or a stout

thread passed through its tip. At a point on each side of the tumor, and about ¾ inch from it, pass a long silk thread through the whole thickness of the tongue in such a manner that the loop of the thread is under the tongue, while its two free ends emerge from punctures on the dorsum (Fig. 240).

Excise the tumor and a wedge-shaped portion of the whole thickness of the tongue by the converging incisions A B, A C (Fig. 240). The excision is most easily effected with the scissors. The bleeding is now liable to be sharp. Tighten and tie the suture which has already been introduced. This stops all hemorrhage. Introduce a few more stitches so that the wound is neatly closed (Fig. 241).

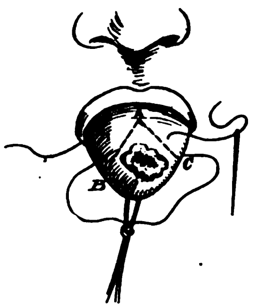


FIG. 240.

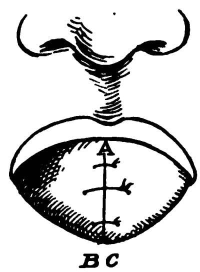


FIG. 241.

The only after-treatment required is frequent cleansing of the mouth with non-poisonous antiseptic washes.

Excision by Elliptical Incisions.—Small tumors of the tongue may be excised under cocain anesthesia by means of elliptical incisions surrounding them. As soon as the neoplasm is removed, bleeding is stopped by the application of a few sutures which at the same time close the wound.

The treatment of lingual thyroids is discussed on page 218.

COMPLETE REMOVAL OF THE TONGUE

As a preliminary to any operation for extirpation of the tongue it is necessary to clean the mouth. The mouth, especially in cases of cancer, is a filthy cavern. The teeth, usually decayed, are covered with tartar and other abominations. The mouth should be thoroughly washed with antiseptic solutions, the teeth vigorously brushed, or, better, cleansed by a good dentist, and loose teeth should be removed. Very many methods of operating have been devised, but only a few of them will be described.

I. Whitehead's Operation.—The following description is taken almost entirely from an article by Whitehead:

1. The patient should be placed in a sitting posture; the head, firmly held, should be inclined forwards so that blood may escape easily. The light must be good and have direct access to the mouth. The patient's mouth and the surgeon's axilla should be at about the same level.

uring the first stages of the operation anesthesia should be complete, rwards only partial insensibility should be maintained.

good gag is essential. It must be one which will not slip and will not ss respiration. [Whitehead's gag, with the tongue depressor absent, bly the best.] With this the mouth is opened as widely as possible. strong ligature should be passed through the tip of the tongue for the of traction.

he tongue is retained within the mouth principally by means of the and the attachments to the anterior pillars of the fauces. These and ction of the mucous membrane between the tongue and jaw must be with scissors. Should any spouting vessels be seen, they must at once it in forceps and twisted; general oozing of blood may be neglected, as soon as the main arteries are discovered and twisted all bleeding "There is, in reality, no difficulty in determining the actual position ngual arteries, as they are practically invariably found in the same i and it requires very little experience to seize them with a pair of for- ore dividing them." The rest of the tongue may be cut away without r. Before completely removing the tongue it is wise to pass a ligature the glosso-epiglottidean fold. This ligature may be left in place for four hours, and permits one to pull forwards the epiglottis should ion be interfered with at any time. Traction on this ligature of itself iemorrhage and makes it an easy matter to secure any bleeding vessel. 'ash the wound with an antiseptic solution.

aint the wound with iodoform styptic varnish. The varnish is made tituting for the alcohol ordinarily used in the preparation of Friar's i saturated solution of iodoform in ether 9 volumes, and turpentine 1

treatment.—Encourage the patient to sit up and move about even as the day following the operation. Give liquid food by the mouth und freely as possible. If necessary, supplement oral feeding by the trient enemata. The mouth is frequently washed and the varnish d daily.

hands of Whitehead this operation has had remarkable primary o to 1891 he had performed it 66 times with but three deaths.

s necessary to remove only one-half of the tongue, the operation the same as above, except that the organ is split in the middle ised half alone excised.

roth Operation.—*Step* 1.—Pass a stout thread through the of traction.

n incision through the skin and subcutaneous tissue from f one masseter muscle to the anterior margin of the other ion follows the lower edge of the lower jaw (Fig. 242). was outlined. The submaxillary region now lies exposed. the posterior ends of the original incision may be angle of the lower jaw.

Step 3.—With scissors or knife penetrate the mouth from below upwards immediately behind the symphysis. Be careful not to injure the periosteum. Separate the structures composing the floor of the mouth from the lower jaw as far back as the anterior pillars of the fauces. Any bleeding vessels are caught up by forceps and either twisted or ligated. The tongue with its traction thread is pulled out through the submental wound and its posterior connections divided with scissors.

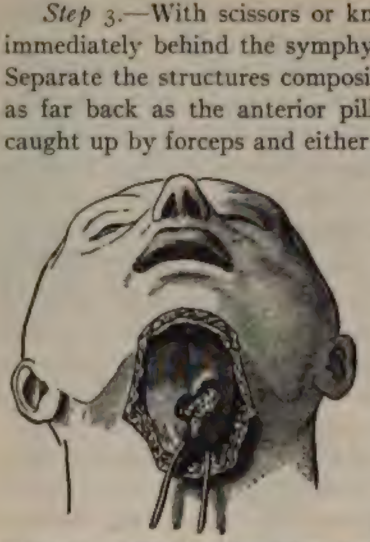


FIG. 242.—Regnoli-Billroth operation. (*Esmarch and Kowalzig.*)

Step 4.—If there is hemorrhage from the stump and it is not easy to locate the bleeding point, hook the forefinger into the pharynx and pull forwards. This simple manœuvre brings the whole stump within reach and the hemorrhage is easily controlled by forceps or suture. A few sutures of silkworm-gut judiciously inserted lessen the extent of raw surface.

Step 5.—Put an iodoform gauze drain in place and close the remainder of the wound with interrupted silkworm-gut sutures.

During this operation all affected or suspected lymphatic tissue must be removed from the submaxillary region.

III. Sedillot's Operation.—In cases of lingual cancer where the floor of the mouth and the jaws are not affected, Kocher ("Operationslehre," fourth edition) strongly advocates Sedillot's operation. The only disadvantage of the procedure is that excision of affected or suspected lymph-glands, etc., if done at the same time as the primary operations, leaves too large and irregular a wound, so that infection can scarcely be avoided. Kocher recommends that the glands be excised at a second operation. Supposing that the disease affects the edge of the tongue posteriorly and has spread to its base, to the anterior pillar of the fauces, the soft palate, and the lateral wall of the pharynx, the operation is carried out as follows:

FIG. 243.—Excision of tongue.

Median division of the lower lip, chin, and skin in submental region as far as the hyoid bone (Fig. 243). Hemostasis. Division of the lower jaw in the middle line. Separation of the divided halves of the jaw with sharp hooks. Median division of the geniohyoid and genioglossal muscles. By means of a traction thread pull the tongue out and towards the sound side. Divide the mucous membrane of the floor of the mouth backwards at the margin of the tongue. This exposes the lingual vein, running backwards and outwards over the lateral surface of the hyoglossus; also the lingual nerve near the border of the tongue, immediately under the mucous membrane. The hypoglossal

nerve is exposed at the outer surface of the hyoglossus, over which it runs inwards and forwards. Between the hyoglossus and genioglossus lies the lingual artery, easily recognized and tied. Divide the hyoglossus with the cautery (Kocher divides all the muscles around the tumor with the cautery). Put great traction on the tongue and, using the cautery, divide the mucous membrane posteriorly, along a line remote from the disease. If the disease extends to the palate and pharynx, divide the styloglossus muscle, and with it the glossopharyngeal nerve. After dividing the mucous membrane in front of the tonsil it can be lifted up by blunt dissection, even when diseased, until the internal pterygoid muscle is exposed. Divide, with the cautery, the soft palate so far as it is diseased, and with it the tensor and levator palati muscles. Now divide the mucous membrane on the posterior wall of the pharynx as far as the longus colli muscle and forwards to the base of the tongue. All this can be done under full guidance of the eye. Lastly, with the cautery, divide the tongue itself, remote from the disease, and sever its nerves, muscles, and vessels (after applying ligatures), or such of these as penetrate the neoplasm. Preserve as many nerves and muscles as possible so as to interfere with deglutition to the minimal extent. Ability to swallow is the greatest preventive against subsequent pneumonia. Rub the wound with a small amount of xeroform. Wire the divided jaw. Do *not* elevate the periosteum when drilling the bone. Close the wound in the soft parts, providing for gauze drainage immediately in front of the hyoid bone. If the patient is placed in the Trendelenburg position, the operation can be done under a general anesthetic without any preliminary tracheotomy. The operation is suitable for all cases except those in which the jaw is affected.

After-treatment.—Until the patient is able to sit up, he should be kept in Trendelenburg's position. On the day following the operation he should try to sit up and attempt to swallow tea or wine with water. Nourishment must be administered through an esophageal tube.

IV. Von Langenbeck's method of excising the tongue is very similar to that of Sedillot, and thus requires no special description, except as regards the incision. On the side corresponding to the disease make an incision from the corner of the mouth vertically downwards to the border of the lower jaw, and continue it downwards to the side of the hyoid bone (Fig. 233). The upper portion of the cut divides the lower lip and gum, penetrating to and exposing the lower jaw; the lower or submental portion at first penetrates only the skin and superficial fascia. Through the lower part of the incision excise all suspected glands (lymphatic and salivary) and ligate the lingual artery. Divide the jaw along the line of incision after boring holes for subsequent wiring. With strong hooks separate the segments of the jaw. The tongue and floor of the mouth are well exposed by this procedure and can be dealt with according to the principles already laid down.

[illegible] **Method.**—In certain cases of extensive carcinoma, and [illegible] isease involves the lower jaw, Kocher advises the following

Step 1.—Put the patient in Trendelenburg's position. Pass a stout thread through the tongue for purposes of traction.

Step 2.—Beginning immediately below the symphysis of the lower jaw, make an incision downwards to a point a little above the hyoid bone; from here cut backwards to the anterior margin of the sternomastoid. Once more change the direction of the incision and continue it upwards along the margin of the sternomastoid to a point near the level of the lobe of the ear (Fig. 244).

Step 3.—Reflect upwards the skin-flap thus outlined.

Step 4.—Excise, *en masse* if possible, all the enlarged glands under the upper end of the sternomastoid and under the angle and horizontal ramus of the jaw. Carefully dissect free the anterior border of the sternomastoid, exposing the carotid packet of vessels and the great horn of the hyoid. Excise the glands in this region.

FIG. 244.—Kocher's operation.

Step 5.—If the cancer affects the floor of the mouth, the fauces, or jaw, it is wise to ligate the facial vein and the external carotid artery.

Step 6.—Expose clearly the anterior belly of the digastric through its whole length, and ligate the veins under it. From below upwards dissect free the packet of glands exposed until the entire posterior belly of the digastric and the stylohyoid muscles lie free in the posterior inferior part of the wound. Detach the mass of glands (lymphatic and salivary) from the lower jaw.

Step 7.—At the posterior end of the great horn of the hyoid divide the insertion of the hyoglossus muscle. This exposes the lingual artery. Tie the artery, but preserve the hypoglossal nerve.

Step 8.—The lower surface of the mylohyoid muscle now lies exposed and on it the mylohyoid nerve. At the posterior margin of the muscle penetrate the mouth (guided by a finger in the mouth) after once more noting the extent and limits of the disease. Beginning at this opening, divide the oral mucous membrane along a line remote from the disease. Attend to hemostasis.

Step 9.—Divide the lingual muscles at the hyoid and remove all infiltrated tissue. It is easy to pull the tongue out through the wound as soon as the oral mucous membrane has been divided.

If a preliminary tracheotomy has been done, the entrances to the larynx should be packed with sterile gauze as soon as the pharynx is opened.

After-treatment.—Leave the lower part of the wound open so that the laryngeal pack may be changed frequently. Every time the dressings are changed (and this must be done very frequently) administer plenty of nutritious food by means of an esophageal tube. As long as the mechanism of deglutition is seriously disturbed keep the patient in more or less of the Trendelenburg position except when he stands or sits up. As long as deglutition is poor the patient must not lie horizontally; he must either sit up or lie with his head and

houlders low. The object of this care is, of course, to avoid pneumonia from the entrance of secretions into the air passages.

The question as to whether the last-mentioned operation should or should not be preceded by a tracheotomy is much discussed. Kocher and Jacobson are strong advocates of this as a preliminary.

The advantages of tracheotomy are the possibility of easy anesthetization; of plugging the pharynx with gauze, thus avoiding inspiration of blood, and of greater freedom in operating.

Butlin advocates preliminary laryngotomy as a safe and convenient substitute for tracheotomy.

When removal of the whole base of the tongue is not necessary Crile passes closely fitting rubber tubes through the nares into the pharynx, to a point opposite the epiglottis, pulls the tongue well forwards and then closely packs the pharynx with gauze. The two tubes after emerging from the anterior nares are connected by a Y, of glass or metal, to a single tube and through this the anesthetic is administered.

The opponents of preliminary tracheotomy believe that this operation, while decreasing the danger of pneumonia from inspiration of blood, yet makes the patient subject to a greater danger of contracting pneumonia from other causes. If tracheotomy is decided on, it should be performed several days before the tongue is attacked, to permit the patient to become accustomed to the new conditions of respiration before his powers are taxed by the very severe operation he is to undergo.

VI. Butlin's Method.*—(A) The disease does not involve the floor of the mouth.

Perform a preliminary laryngotomy (p. 234).

Pack the pharynx to prevent blood gravitating into the larynx.

Step 1.—By Whitehead's method or some modification thereof, remove the local disease with 3/4 inch of apparently healthy tissues around it in every direction. Where the disease is on the border of the tongue, it is best to remove that half of the tongue to an inch behind the cancer.

After about nine days, when the patient is able to take plenty of liquid food, proceed to Step 2.

Step 2.—Make an incision along the anterior border of the sternomastoid from near the mastoid process to the sternoclavicular articulation. Make an incision from the *symphysis menti* to meet the previous incision, just above the thyroid cartilage. Reflect the two triangular flaps of skin thus outlined and expose the platysma myoides and fat of the anterior triangle of the neck.

Step 3.—Beginning *below*, expose the sternomastoid and retract it backwards. Expose the carotid packet of vessels, dissecting from below upwards, and separate from it every particle of fat, whether superficial or deep, anterior or posterior. Be careful to remove the fat between the parotid and the vessels. All this fat ought to be left attached to that of the rest of the anterior triangle, otherwise the operation is liable to be incomplete (Fig. 245). Working from

* Butlin, "Op. Surg. Malignant Dis.," second ed., "Brit. Med. Jour.," Feb. 15, 1905.

the region of danger (carotid packet) and from below upwards, remove *en masse* all the fat in the anterior triangle and with it the submaxillary salivary gland, leaving the muscles quite bare. In the submental region complete the dissection by searching between the geniohyoid muscles, lest a gland be overlooked.

If the disease involves the contents of the carotid packet, these must also be removed. The internal jugular vein more often requires removal than does the carotid artery.

Step 4.—Place one strip of gauze in the submaxillary triangle beneath the jaw and another between the parotid and the vessels. Bring the ends of the gauze out at the lowest part of the wound. Provide tubular drainage also.

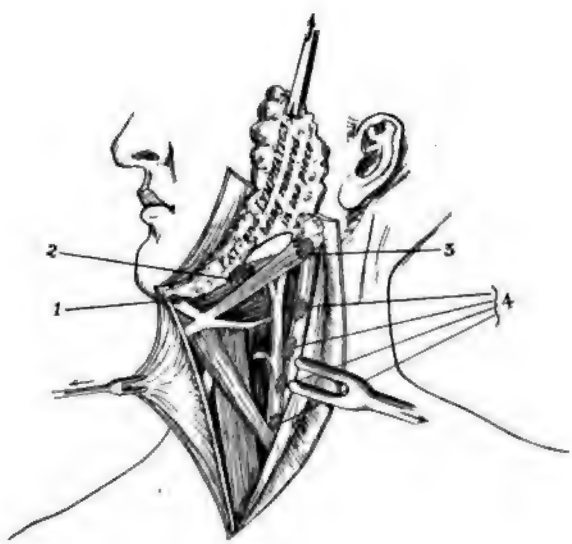


FIG. 245.—Butlin's method for excision of the tongue.

Sketch indicating the position of the most important lymph nodes, all of which are supposed to have been dissected out and removed. 1. Location of submental group lymph nodes. 2. Location of submaxillary group lymph nodes. 3. Location of parotid group lymph nodes. 4. Location of carotid group lymph nodes.

Close the wound. Damage to the parotid will permit a leakage of saliva, but this ceases in a few days.

The principles of Butlin's operation are: (1) Operation in two stages is much safer than in one. (2) The glands are involved very early in lingual cancer, but the lymphatic vessels between the primary lesion and the secondary seem to escape.

Mr. Butlin's results have been so remarkable that no apology is necessary for reproducing the statistics of seventy cases in which he was permitted to complete the operation in the manner he advocates. A study of Butlin's specimens and drawings gives great encouragement in the treatment of cancer of the tongue even when apparently advanced:

ıalysis of the seventy cases in which the contents of the anterior triangle removed:

ıf the operation	6
ght of after operation	1
ıf recurrence in the mouth	9
ıf recurrence, uncertain where (in one of these the glands could not be entirely removed; operation abandoned)	7
of recurrence in the glands (in one of these the submaxillary salivary gland was ft and the disease recurred beneath it; in the other seven cases the glands were nlarged at the time of their removal, and in five of these they were demonstrably ıncerous)	8
ıf cancer on the opposite side of the tongue	1
ıf affection of glands on opposite side of neck	2
ıf other disease within three years	1
not countable (operation too recent)	11
sful cases	24
otal	70

he successful cases are calculated on the seventy cases, after deducting not countable (11), the patient who died within three years of another se (1), and the patient who was not traced after the operation (1), leaving even cases, with twenty-four successful cases = 42.01 per cent.

ıe age of the patients operated on showed that ten of them were over ars of age, and one over 70 years (77).

ıe causes of death from operation were:

rhage, etc. (both from mouth and neck in a badly alcoholic patient)	1
ıtion (from the sudden falling back of the root of the tongue some days after eration)	1
pneumonia	4
tal	6

) **The disease** involves the floor of the mouth to such an extent that the **ıccal operation** is impossible.

move the tongue by any of the methods already described, and according **condition of the patient** remove the glands of the neck either at the same **a subsequent séance.**

hatever operation is chosen for removal of lingual cancer, it is always the importance to remove *en masse* the whole of the related lymphatic tory, even if the primary lesion appear trivial and the lymphatics show croscopic involvement.

ile ("Journ. Am. Med. Assoc.," Dec. 1, 1906) reports remarkably ble results from an operation similar to, but more extensive than Butlin's. lymph nodes are palpably enlarged, further metastasis is sure to be ce, therefore Crile removes the whole lymphatic-bearing tissue on the ed side; when there are no palpably enlarged glands he only removes the hatics next in order.

In operating on the former class of cases Crile temporarily compresses the common carotid with his special clamp, doubly ligates and divides the internal jugular vein low down in the neck and excises the vein along with the lymphatic tissues, and the muscles of that side of the neck (Fig. 246).

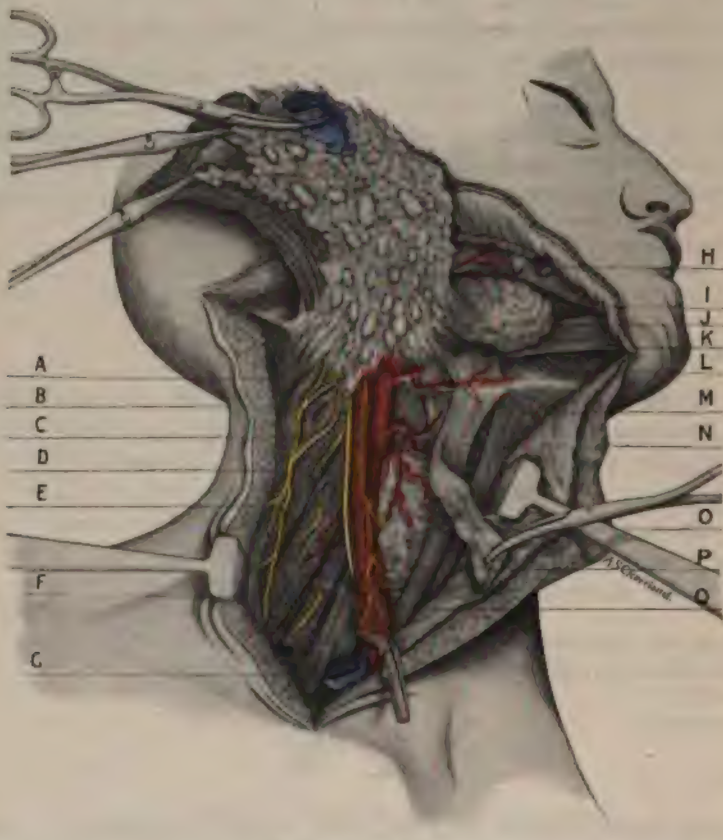


FIG. 246.—(*Crile.*)

The entire mass of lymphatic gland bearing tissue is excised *en bloc*, and handled as little as possible. This dissection becomes easy when followed in the deep plane. The entire block of tissue is finally divided above, including the vein. A, splenius. B, hypoglossus descendens. C, spinal accessory. D, elevator ang. scapuli. E, pnuemogastric. F, scalenus posticus. G, internal jugular. H, facial vein and artery. I, submental. J, submaxillary. K, digastric. L, mylohyoid. M, sternohyoid. N, omohyoid. O, thyroid gland. P, thyrohyoid. Q, carotid.

VII. Maitland's Operation.—Maitland ("The Australasian Med. Gazette," Oct. 20, 1906) describes a thorough operation which has given him much satisfaction and which he practises in all except *very early* and *very late* cases. Fig. 247 shows Maitland's incisions. The following paragraphs are copied from the article to which reference has been made.

"*Dissection of the Digastric Triangle.*—A clean dissection is then made of this triangle, beginning at the point of the chin and working outwards and upwards, paying particular attention to the spaces between the outer edge of the mylohyoid and the hyoglossus, as glands are easily overlooked in these

situations. The anterior layer of the outer portion of the deep cervical fascia, which here forms a compartment for the submaxillary gland, is opened; the glands pulled forwards, the facial artery tied and divided, the common facial and anterior division of the temporo-maxillary veins having been previously tied and divided. The dissection of this anterior portion of the digastric triangle is then completed by carrying the dissection well up over the body of the mandible, so as to remove the lower of the facial glands. That portion of the digastric triangle posterior to the stylo-maxillary ligament containing the parotid is next cleared and the lower portion of the parotid is removed. This dissection is carried sufficiently deep to remove the deep parotid glands; this step has been insisted on by Butlin. I have regularly carried it out for some years.

"*Division of the Sternomastoid.*—Before this step in the operation is performed the dissection of the anterior triangle is begun from before backwards till the anterior border of the sternomastoid is reached. This muscle is then divided at the level of the omohyoid, the lower portion being turned down.

"*Dissection of the Anterior and Posterior Triangles.*—The dissection of these two triangles is then proceeded with from below upwards, cleaning all the fascia off the vessels. The dissection is carried on right up beneath the parotid, the dissection being completed by removing the sternomastoid muscle at its insertion, together with the contents of the anterior and posterior triangles. By this means the whole of the deep descending cervical chain of glands is removed.

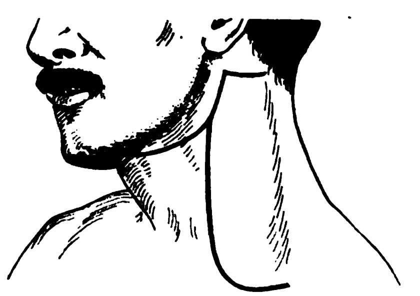


FIG. 247.—Maitland. (*Australasian Med. Gaz.*)

"*Removal of Internal Jugular Vein.*—This is done as the last step of the operation; if it be done earlier in the operation much valuable time is lost in stopping venous hemorrhage. I am firmly of opinion that only by removing the sternomastoid muscle can the deep cervical chain of glands be thoroughly removed. The internal jugular vein I do not always remove, as with the removal of the sternomastoid muscle, as I suggest, the vein can be more thoroughly cleared both on its anterior and posterior aspects.

"*The Effect of Removal of the Sternomastoid Muscle.*—All the movements of the head are, as I show you from these cases, thoroughly carried out by the post-rotators, and the removal of the muscle practically in no wise interferes with the head movements. The text-books advise preservation of the muscle,

because of the supposed interference with the movements of the head; but this view I know to be erroneous.

"*The Division of the Spinal Accessory.*—This is done in nearly every case, and only in two instances have I seen drooping of the shoulders; the third and fourth cervical are sufficient to preserve the function of the muscle."

VIII. A. P. C. Ashhurst's operation is sufficiently described by illustrations 248, 249 and 250 (Annals of Surg., Aug., 1915).

IX. Spischarny's Suprahyoid Operation. (Archiv für klin. Chir., xcii, p. 1212).—*Step* 1.—Make a transverse incision above the hyoid bone from one

FIG. 250.—After removal of tongue, floor of mouth is covered partially by suturing mucosa of cheek across alveolus to stump of tongue. A hemostat is on the right lingual artery in the floor of the mouth. (*Ashhurst, Annals of Surgery.*)

sternomastoid to the other. If necessary enlarge the wound by longitudinal incisions along the sternomastoid muscle. Remove the lymphatic glands and with them the submaxillary salivary glands, if the floor of the mouth is affected. Ligate and divide both lingual arteries. Divide both hypoglossal nerves.

Step 2.—Separate the root of the tongue from the hyoid bone and open the pharynx in the angle between the tongue and the epiglottis (Fig. 251). All the diseased structures (even, if required, the tonsils, pillars of the fauces and floor of the mouth) can now be isolated under guidance of the eye.

Step 3.—Open the mouth and through it divide the anterior attachments of the tongue. Remove the tongue.

FIG. 248.—The neck dissection has been completed, the cervical lymphatics and fat still attached to skin flap. The neck wound is then tamponed with gauze. (*Ashhurst, Annals of Surgery.*)

FIG. 249.—The cheek has been turned aside, exposing the tongue. The left anterior pillar of the fauces has been divided, and the scissors are now dividing that on the right. (*Ashhurst, Annals of Surgery.*)

4.—Suture together the remnants of muscles attached to the chin and id bone. Carefully reunite the digastric muscles to the hyoid. Close nd leaving a narrow canal to the pharynx for purposes of drainage.

a soft œsophageal catheter through the nose into the œsophagus it feeding during the first few days.

charny states that preliminary tracheotomy is unnecessary if the n is performed in Rose's position.

Vallas' Transhyoid Operation.—When cancer is limited to the base of gue near the epiglottis, or when it affects the epiglottis, **Vallas' operation shyoid pharyngotomy** gives good access to the parts. This operation

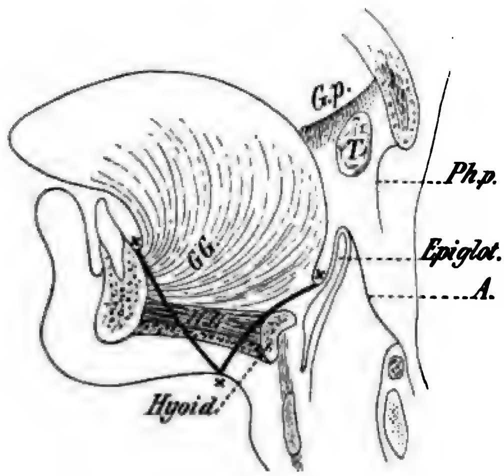


FIG. 251.

suitable for the removal of foreign bodies and the treatment of syphilitic res. Preliminary tracheotomy is not essential.

e Operation.—*Step* 1.—**Make a median incision through the skin and taneous tissue from the symphysis of the lower jaw** to the superior angle **e thyroid cartilage.**

Step 2.—**With blunt or sharp dissection separate,** in the middle line, the **s of the mylohyoid muscles in such fashion as** to expose the upper border **e hyoid bone in the median line.**

Step 3.—**With scissors or bone forceps divide the** hyoid bone in the middle **Retract the halves of the bone along with the** fibres of the mylohyoid **le. This gives us a space 1½ inches in width.**

Step 4.—Th[illegible] part of the wound is separated from the pharynx by the hyoid [illegible] he upper part [illegible] mucosa. To reach the pharynx, the [illegible] nbrane; to [illegible] base of the tongue or floor of the [illegible] ess has [illegible] gained to the seat of the disease. [illegible] described [illegible] n the removal of the neoplasm; [illegible] the prin[illegible] ly enunciated. Having completed

the excision, close the wound, providing drainage at its lower end. No special suture of the hyoid bone is required.

XI. Abadie's Operation.—The carcinoma affects the floor of the mouth superficially—has spread to the tongue and to the alveolar mucosa anteriorly;

FIG. 252.

the muscles of the floor of the mouth are not involved. Abadie's operation may be valuable ("Arch. provinciales de Chir.," xx, 725; Ref. "Journ. de Chir.," April, 1912). Fig. 252 shows diagrammatically a case suitable for the operation and the lines of incision.

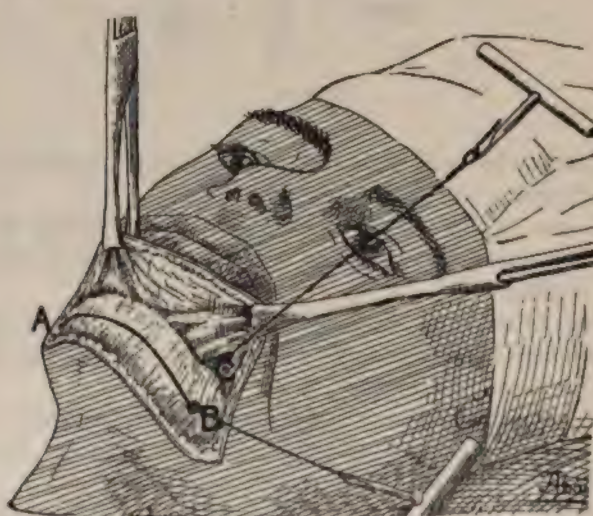


FIG. 253.

Step 1.—Make an incision along the lower border of the inferior maxilla from one masseter to the other. Dissect upwards so as to separate all the soft parts from the front of the jaw until the mouth is freely opened along the line

reflection of the mucosa from the jaw to the lips. Reflect upwards as a visor the flap thus formed.

Step 2.—According to the extent of the lesion select the two extreme points of the line of section of the bone (A and B, Fig. 253). At these points perforate the bone with a drill. With an amputation saw divide the bone along the line AB. Pass a Gigli saw through the perforation at B and divide the alveolus along the line BC. Do the same at perforation A.

Step 3.—Seize the mobilized segment of bone with lion-jaw forceps and pull it upwards and forwards. With scissors cutting horizontally from before backwards, dissect up the disease on the floor of the mouth, then cutting upwards and forwards excise the disease from the tongue along the lines shown in Fig. 238. Attend to hemostasis.

Step 4.—Close the wound in the tongue with sutures. Unite the mucosa of the tongue to that of the lip. Replace the visor-shaped flap of lip and suture the skin wound after providing for drainage. Before, during, or after Abadie's operation, the lymphatic territory ought, of course, to be cleared of its glands and fat as in any other operation for cancer of the tongue.

CHAPTER XVII

PAROTID GLAND

From the standpoint of operative surgery tumors of the parotid may be divided into two classes:

1. Those which are encapsulated inside the gland. This encapsulation may not be perfect, but there is no general infiltration of the gland by the disease. Such tumors are the adenomata and the mixed tumors of feeble malignancy.

2. Those tumors which infiltrate the gland substance. Such are the sarcomata and carcinomata.

The principles of operation which may be applied to both classes of tumors alike are: (*a*) Early operation; (*b*) free exposure of the growth by suitable incisions; (*c*) careful hemostasis.

When the tumor is one of those encapsulated within the gland, it should, if possible, be enucleated with its capsule, leaving the gland as little injured as is practicable. When the capsule cannot be removed with the growth, it should be removed afterwards as thoroughly as circumstances permit. The facial nerve must be preserved. An incomplete operation often gives good results, but completeness must always be the aim. When the tumor is of the infiltrating type, the *whole* gland with its fascial coverings or capsule must be removed, and with it any adherent skin. Little attention may be given to the facial nerve; its destruction is almost certain. T. Carwardine and Gunn have each preserved the facial nerve in such operations. The necessary dissection must take very much time and in feeble patients this constitutes no mean risk. As in the case of cancers located elsewhere, too much rather than too little must be done. If the surgeon believes that the whole growth cannot be removed, it is better to abstain from operation. An incomplete operation is worse than useless.

I. Enucleation of Parotid Tumors.—(A) The tumor is small, mobile, and apparently easily removed: Make a horizontal incision over the prominent portion of the growth, parallel to the course of the fibres of the facial nerve and of length sufficient to permit of removal of the tumor under guidance of the eye and without bruising of the wound. Incise the gland substance so as to expose the tumor, which must now be shelled out. Attend to hemostasis; in doing this, suture-ligatures involving the gland substance should be avoided, as they are liable to constrict branches of the facial nerve and salivary ducts. Close the wound with or without drainage.

(B) The tumor is not large and not suitable for the simple procedure described above:

Step 1.—Beginning at the tip of the mastoid process, make an incision downwards along the anterior edge of the sternomastoid, to the level of the

angle of the lower jaw; from this point cut forwards and upwards, in a curve, over the ascending ramus of the jaw, until a flap is outlined which when elevated will expose most of the tumor. The flap consists of skin and superficial fascia alone; no deeper structures must be involved because of the facial nerve.

Step 2.—The growth of the tumor inevitably pushes aside and spreads out the glandular tissue in which it lies. Examine the exposed surface for that part least covered by glandular tissue. The tumor capsule will generally be seen at once; if not, expose it by dividing *horizontally* any overlying glandular substance. If the capsule is strong, proceed to do an extracapsular enucleation by blunt dissection. Any bands of tissue passing to the capsule from its surrounding must be doubly ligated and divided. First free the anterior border of the tumor, then the posterior, and dissect free its deep surface *from below upwards* so as to gain early control of the vascular supply. Proceeding in this fashion, it is often possible to enucleate the tumor *en masse*, but often enough some deeply seated fragments are left behind; such must now be removed individually.

If the capsule is weak and the tumor soft, extracapsular enucleation is impossible. Under these circumstances freely incise the capsule, clean out its contents, and remove the capsule bit by bit as thoroughly as possible. This apparently very imperfect operation often gives excellent results. With regard to enchondromata of the salivary glands Jacobson writes: "It is not uncommon for branches of the facial nerve to be in relation with the capsule of the tumor, and if this had been much handled, or treated by counter-irritation, they may very likely be firmly adherent. In either case injury to the nerve may be best avoided by slitting up the capsule and shelling out the enchondroma first. The capsule should then be examined to see if any nerve branches are adherent to it; after these have been separated, the capsule itself should be removed. This should always be done to prevent any recurrence, as the peripheral part of these enchondromata is often adherent to the capsule itself." ("Operations of Surgery," i, 340).

Step 3.—Attend to hemostasis. Close the wound by sutures. Drain dead spaces. Dress.

II. Excision of the Parotid.—Excision of the parotid is necessary in cases of malignant neoplasms, such as carcinoma or sarcoma. As these tumors are infiltrating in character, enucleation is impossible and useless; the whole gland must be removed, whether evidently affected or not.

Step 1.—Make a ⊢-shaped incision (Fig. 254) of sufficient extent, through the skin. Reflect the skin so as to expose all the parotid covered by its fascia.

Step 2.—Mobilize the anterior edge of the gland and tumor. Doubly ligate and divide the vessels situated here and Steno's duct. Forceps may be used instead of ligatures during the dissection. Separate the gland from the masseter, working from before backwards, doubly ligating all vessels before dividing them.

Step 3.—Separate the lower edge of the gland (submaxillary portion) from its surroundings by blunt dissection, doubly ligating and dividing the vessels.

Step 4.—Expose the upper end of the anterior portion of the sternomastoid, open its sheath, and retract the muscle backwards. That portion of the sheath adherent to the fascia covering the parotid must be removed with the tumor.

Step 5.—By blunt dissection, working from below upwards and elevating the lower edge of the gland, expose the external carotid artery as it passes under the stylohyoid and digastric muscles. Doubly tie and divide the artery. Mobilize the tumor and gland up to the level of the styloid process.

Step 6.—Separate by blunt dissection all connections between the tumor and the temporo-maxillary joint. Ligate and divide the temporal vessels at the level of the zygoma.

Step 7.—Pull the gland, etc., backwards, expose the numerous veins which run along with the internal maxillary artery, from behind the neck of the lower jaw into the gland. Doubly ligate this leash of vessels and divide them.

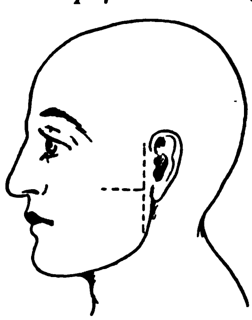


FIG. 254.—Excision of parotid.

Step 8.—Separate by blunt dissection the posterior and pharyngeal connections of the gland, doubly ligating or clamping all vessels before dividing them. In making this last dissection be on the lookout for and avoid injury to the internal jugular vein.

Step 9.—Attend to hemostasis. Close the wound with sutures after providing for drainage.

Any enlarged lymphatic glands near the parotid ought to be removed along with the tumor. The operation is a difficult one, and ought not to be attempted by the inexperienced.

Zarraga's Method. ("Journ. de Chir.," Sept., 1912).—1. From the tip of the mastoid make an incision downwards along the anterior edge of the sternomastoid to a point a little below the angle of the lower jaw. Continue the incision forwards immediately below and parallel to the lower jaw until the anterior border of the masseter is reached. Continue the incision upwards along the anterior edge of the masseter to terminate on the zygoma.

2. Reflect upwards the skin flap thus outlined. This exposes the sternomastoid, the facial nerve, the parotid, the masseter and the lower jaw in front of it, the facial artery, the zygoma.

3. With elevator and knife bare the bone of the lower jaw just in front of the masseter and divide it with Gigli's saw. Divide the masseter at its zygomatic insertion. Divide Stenon's duct.

4. Grasp the ascending ramus of the jaw with lion-jawed forceps and dislocate it outwards and backwards, at the same time dividing the internal pterygoid muscle, ligating the inferior dental vessels and dividing the tendon of the temporal muscle (Fig. 255).

5. Ligate the external carotid immediately before it enters the parotid; ligate the internal maxillary as it passes behind the condyle of the inferior maxilla. Ligate the superficial temporal and the posterior auricular arteries.

6. Remove the gland and the ascending ramus of the jaw together. One

at this time can see if the pharyngeal prolongation of the parotid is adherent to the carotid packet and if necessary separate the adhesions.

Salivary Fistula.—A salivary fistula most commonly results from disease or injury of Steno's duct. In some cases a stricture is present distal to the fistula, and if this is dilated, the fistula either closes spontaneously or after its orifice has been stimulated by the cautery or revivified and sutured. When the above simple treatment is inappropriate or has failed, operation becomes necessary.

I. The fistula is anterior to the masseter muscle.

(A) *Von Langenbeck's Operation.*—Make the proximal portion of the duct (*i.e.*, the segment of duct next to the parotid gland) prominent by passing a

FIG. 255. (*Journ. de Chir.*)

probe into it, through the fistula. With a knife or scissors separate the fistula and duct from their surroundings, leaving them attached to the gland. In a convenient location pass the knife from the wound into the mouth, perforating the buccal mucosa. Pull the free end of the mobilized duct into the mouth through the perforation in the mucosa and fix it there with sutures. Close the external wound. When applicable, the above is the best operation for salivary fistula, but unfortunately it is not often available, as the unnatural orifice is usually far back near the origin of Steno's duct behind the anterior margin of the masseter.

(B) *Deguise's Operation.*—From the fistula make two perforations into the mouth, about ¼ inch apart. Through these openings pass the two ends of an

elastic ligature, a piece of lead wire, or a stout silk suture. Fasten together the ends of the ligature in the mouth so as to exercise pressure on the included tissues. Necrosis of the tissues follows and a permanent opening into the mouth is assured. Freshen the edges of the cutaneous fistula and unite them by sutures. The elastic ligature or lead wire may best be introduced through a cannula which is made to perforate the cheek from within outwards (Figs. 256, 257). A silk suture is best inserted from without inwards by means of a needle at each end.

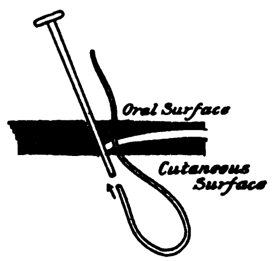


FIG. 256.

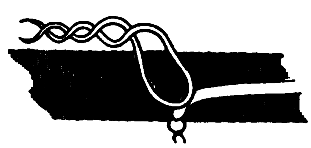


FIG. 257.

FIGS. 256 AND 257.—Deguise's operation.

(C) *Kaufmann's Operation.*—Pass a cannula (about 1/8 inch in diameter) from the fistula into the mouth and through it introduce a rubber tube or seton. Remove the cannula, leaving the seton in place. Whenever the track of the seton has become covered with epithelium, remove the seton and close the cutaneous orifice of the fistula.

II. The fistula is situated in the masseteric portion of Steno's duct.

(A) Either Kaufmann's seton or Deguise's method of double puncture may be used, but neither the seton nor the constricting ligature must perforate the

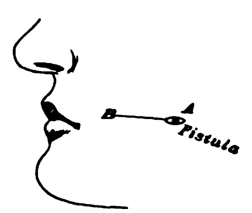


FIG. 258.—Braun's operation.

masseter. The puncture or punctures must pass from the fistula to the mouth by tunnelling between the masseter and the skin.

(B) Von Langenbeck's method may be used if a sufficient length of duct remains attached to the gland. In this method it is necessary to puncture the masseter and pull the mobilized portion of duct through the puncture into the mouth. Instead of being punctured, the masseter may be divided transversely, and if necessary a portion of the ascending ramus of the lower jaw may be cut away with rongeurs so that the defective duct may gain access to the mouth.

(C) Plastic formation of a new duct (Braun's operation): Make the incision

A, B (Fig. 258). Mobilize the fistulous orifice by dissecting it free from the skin. The incision penetrates all the tissues of the cheek except the mucosa and masseter. Retract the edges of the wound, exposing the outer surface of the mucosa (Fig. 259). From the mucosa construct a flap with its pedicle at the edge of the masseter, of length sufficient to reach from the masseteric edge to the fistula. Turn this flap back over the masseter; suture its free end to the fistula; suture its upper and lower edges together so as to form a tube lined with epithelium (Fig. 260). Close the skin-wound.

FIG. 259.—Braun's operation.

(D) *Crouse's Operation.*—This operation is very similar to that of Braun but is simpler and of wider application.

Step 1.—Make a 3 cm. (1¼ in.) incision through the skin and fat straight downwards from a point 2 cm. below the zygoma and 2 cm. in front of the ear. This avoids injury to nerves and vessels. Expose the fascia covering the parotid and make a 1 cm. incision in it.

Step 2.—Grasp the lip, turn the cheek out and reflect a flap of mucosa, about ¼ inch wide and thick enough (⅛ in.?) to be reliably viable, beginning near

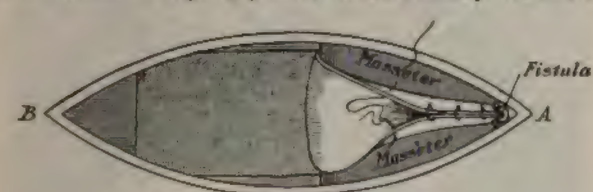


FIG. 260.—Braun's operation.

the vermilion line of the upper lip and running back to slightly behind the level of the second upper molar. The pedicle of this flap is posterior.

Step 3.—Pass a curved hemostat through the external incision on the cheek and pass it forwards hugging the surface of the masseter and force it into the mouth just in front of the pedicle of the intra-oral flap (Fig. 261). Open the forceps and dilate the tunnel. Grasp the end of the flap in the forceps and pull it through the tunnel. Pass a No. 0 chromic gut suture in the Lembert fashion through the mucous surface of the flap near its free end (Fig. 262) and through the pos-

FIG. 261.—(*Crouse, Surg., Gyn. & Obst.*)

FIG. 262.—(*Crouse, Surg., Gyn. & Obst.*)

rior edge of the incision in the parotid fascia. Tie the suture but leave its ends long. Pass a fine forceps from the external wound through the tunnel into the mouth and catch with it the middle of a ligature of No. 5 chromic gut. Pull this thread through the wound and tie the long ends of the fine suture to its loop leaving the long ends of the coarse ligature in the mouth. The mucosal flap assumes a tubular form around the coarse ligature. Close the external wound. Crouse has used his operation five times with success (Surg. Gyn. and Obst., May, 1915).

Anastomosis between the Parotid and Submaxillary Glands.—In cases in which lesions of Stenon's duct seriously interfere with excretion from the parotid Ferrarini (Zent. f. Chir., 13, June, 1914) has shown the possibility of establishing drainage through a parotid-submaxillary anastomosis.

Expose the submaxillary gland by an incision parallel to and below the horizontal ramus of the lower jaw. Continue the incision back to, and around the angle of the jaw so as to freely expose the lower part of the parotid. Open the capsule of, and mobilize bluntly, the submaxillary gland. Isolate and mobilize the lower end of the parotid behind the angle of the jaw. Make incisions in or pare off corresponding portions of the two glands and suture the raw surface of one gland to the raw surface of the other. Close the external wound. This operation has been an experimental success but has not been used clinically.

CHAPTER XVIII

OPERATIONS UPON THE NOSE

EXCISION OF INTRANASAL MALIGNANT TUMORS

DENKER'S TRANSMAXILLARY METHOD*

Step 1.—With blunt hooks pull the angle of the mouth and the upper lip upwards and outwards. Beginning opposite the wisdom tooth on the affected side make an incision through the gum of the upper jaw to a point near the frenum of the upper lip. The incision should be slightly curved upwards. With an elevator separate the soft parts from the upper jaw until that bone is exposed nearly to the lower margin of the orbit and the pyriform aperture of the nose is laid bare.

Step 2.—With a fine elevator or dissector, beginning at the pyriform aperture, separate the mucous membrane from the outer wall of the lower and middle sinuses of the nose and partly from the floor of the nose. Continue this separation backwards to the posterior limits of the antrum of Highmore. If the lower turbinated bone is not involved in the tumor, remove it with strong scissors. Temporarily pack with gauze for hemostasis.

Step 3.—With chisel and rongeur remove the external bony wall of the antrum of Highmore. If the mucosa lining the interior surface of this wall is healthy incise it freely so as to gain free access to the sinus; if it is involved in the growth, extirpate it with the growth. With chisel and rongeur remove *completely* the inner or nasal wall of the antrum, both the bone and the mucosa.

Step 4.—With scissors or probe-pointed knife remove the mucosa of the outer wall of the nose (already separated in Step 2). If the tumor has arisen from the middle sinus of the nose it generally will come away with the nasal mucous membrane. Free access is now attained to the ethmoidal and sphenoidal sinuses which can be treated according to circumstances.

Step 5.—Pack the wound with gauze. Suture the oral wound. Keep the mouth clean with washes. Remove the pack after three or four days.

The above operation is *not* suitable for cases of tumors arising from the nasopharynx, retro-maxillary or pterygo-palatine fossæ.

RHINOPHYMA (ACNE HYPERTROPHICA)

This deforming disease must be treated by operation. If the tumors are pedunculated their removal requires no special description, if they are extensive and non-pedunculated proceed as follows:

* "Münchener med. Wochenschrift," 1906, No. 20.

Give a general anesthetic.

Step 1.—Through the anterior nares introduce gauze strips and so plug the posterior two-thirds of the nose, leaving the anterior portion free. This prevents the inflow of blood. Plugging of the posterior nares will do as well.

Step 2.—Put the forefinger of the left hand into one nostril as a guide. Make an incision down to but not into the cartilage, all round the growth from the middle line outwards (Fig. 263).

Be sure to leave as much skin as possible near the opening of the nares to avoid subsequent stricture.

Step 3.—Seize the median edge of the tumor mass with forceps and entrust these to the assistant (Fig. 264). With knife or scissors shave off all the diseased tissues within the circle of the incision. Attend to hemostasis with forceps, ligature, pressure with hot pads or the thermo-cautery.

FIG. 263.

FIG. 264.

FIGS. 263 AND 264.—Rhinophyma. (*Laurens*.)

Step 4.—Repeat Steps 3 and 4 on the opposite side.

Step 5.—Remove the nasal plugs. Introduce short drainage tubes into each nostril. Cover the wounds with rubber tissue, perforated oiled silk or silver foil. Apply compressive dressings. The results in time are very good. Skin grafting is rarely necessary.

Angioma of Nose.—Angiomata of the nose are not uncommon and may often require no treatment. Often, however, they are so disfiguring as to prevent their possessors from earning a livelihood.

When small, angiomata may be treated by freezing (liquid air, carbon-dioxide snow), by electrolysis, by application of nitric acid, by ignipuncture, etc., but a large, pulsating tumor demands excision. In the patient shown in Figs. 265 and 266 ("Lancet," March 23, 1912), Mr. Battle ligated the external carotid, the superior thyroid and the facial arteries on both sides and then cut away the nasal disease leaving the bony and cartilaginous framework of the nose exposed. About three weeks later the central portion of the lip was excised and later the

nasal wound was covered by a flap taken from the forehead in the Indian method. The result was gratifying.

Epithelioma of Nose.—In order to excise not merely the tumor but at least

FIG. 265.—(*Battle.*)

FIG. 266.—(*Battle.*)

¾ inch of apparently healthy tissue all around and in one piece with these lymphatic nodes next in order Henry Curtis (Trans. Royal Soc. Med. Clin. Sect., April, 1914) operated as follows: (The tumor was situated on the left

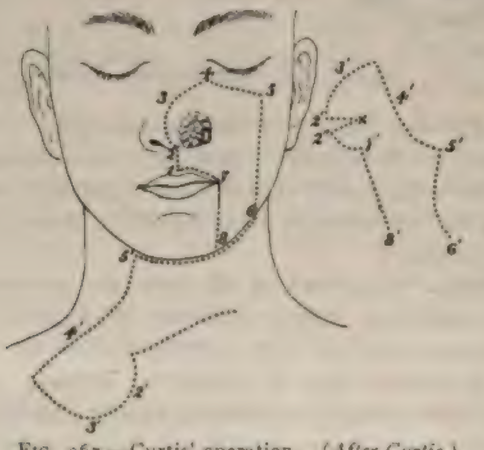


FIG. 267.—Curtis' operation. (*After Curtis.*)

side of the tip of the nose, the submaxillary glands were small and hard); the incision 1–6 (Fig. 267) was made. On the columella the cut penetrated to the cartilage; elsewhere it reached the bone or penetrated the nose and mouth.

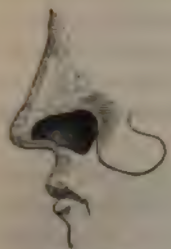


FIG. 268.

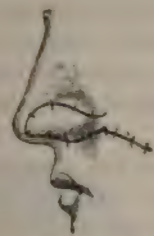


FIG. 269.

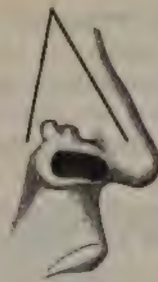


FIG. 270.

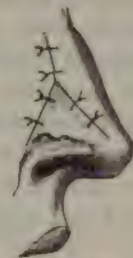


FIG. 271.

FIGS. 268, 269, 270 AND 271.—(*Esmarch and Kowalzig.*)

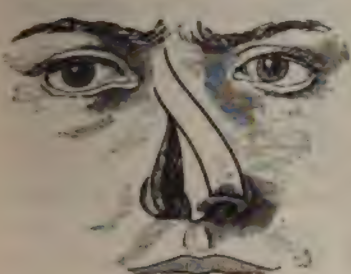


FIG. 272.

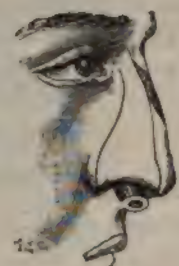


FIG. 273.

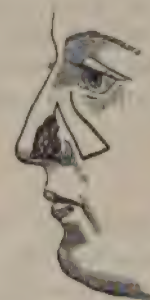


FIG. 274.

FIGS. 272, 273 AND 274.—(*Esmarch and Kowalzig.*)


FIG. 275.


FIG. 276.

FIGS. 275 AND 276.—(*Esmarch and Kowalzig.*)

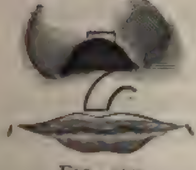


FIG. 277.

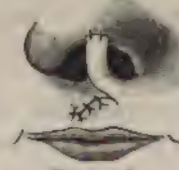


FIG. 278.

FIGS. 277 AND 278.—(*Esmarch and Kowalzig.*)

From the beginning of the original cut in the median line of the upper lip, a second incision was made (1–7) just skirting the red margin of the lip to the left angle of the mouth, and then vertically down (7–8) to reach the lower border of the mandible. The flap outlined by the cuts 8–7–1–2–3–4–5–6 included the entire left nostril, the whole thickness of the cheek and exposed both the nasal and oral cavities.

An incision penetrating the *skin alone* was now made between the points 6 and 8 and the cheek flap was removed with the lymphatics and glands *en masse.* "Those removed consisted of the left maxillary glands, just below the orbit, the lymphatic vessels (and ? glands) in the left buccinator region, both submaxillary, salivary and lymphatic glands, both submental glands, and the left superficial and deep cervical glands." To expose the glands below the jaw and to provide a flap to repair the defect in the nose and cheek the incisions 8, 5′, 4′, 3′, 2′ were made and the outlined flap was fixed by sutures into its new bed. A split made in the flap (Fig. 267 insert 2′–2″–x) aided in fashioning the new nostril. The wound in the neck was easily closed. The result was satisfactory after some subsidiary patching operations had been done.

RHINOPLASTY

Rhinoplasty, or the reconstruction of the nose, is called for in cases where the nose has been destroyed by disease or operation. The character of the operative interference required varies with the location and extent of tissue destruction.

I. The destruction is confined to the soft structures of the nose but the osseous and a part of the soft structures of the nose remain.

A. A relatively small portion of the soft parts has been destroyed. Figs. 268, 269, 270, 271 sufficiently explain the correction of this defect.

1. The defect is confined to one ala. Fritz König ("Berlin. klin. Woch.," 1902, No. 7), after thoroughly freshening the nasal defect, implanted into it a properly shaped segment consisting of the whole thickness of the concha of the ear. The result was excellent.

2. The defect extends beyond the ala but is still lateral.

Langenbeck's Operation.—From the sound side of the nose reflect a skin-flap, which has its base near the inner angle of the eye of the affected side (Figs. 272 and 273). Suture the flap thus obtained to the edges of the defect, which have, of course, been vivified immediately before. Cover the raw surface left by the elevation of the flap with Thiersch's skin-grafts.

Nélaton's Operation.—This is similar to the preceding, but the flap is obtained from the cheek (Fig. 274).

3. The septum is absent.

Dieffenbach's Operation.—Make a flap as outlined in Fig. 275, consisting of the whole thickness of the upper lip. Freshen the distal end of the flap, turn it forwards, and suture it to a vivified area on the anterior edge of the nasal opening (Fig. 276). Close the wound in the lip.

Langenbeck makes a flap from the skin of the upper lip, leaving the deeper structures intact (Figs. 277 and 278).

Both of the above methods are faulty in that use is made of very hairy skin, and annoyance is sure to result.

Lexer makes a flap from the mucous and submucous structures of the upper

FIG. 279.—Lexer's operation.

lip, leaving the skin intact except for a perforation through which the flap is brought into position (Figs. 279 and 280).

Hueter uses a flap of skin obtained from the nose itself (Figs. 281 and 282).

B. Practically all the soft structures of the nose are absent.

1. **Indian Methods.**—In this operation a pedunculated flap is taken from the forehead and sutured to the nasal defect.

FIG. 280.—Lexer's operation.

The Operation.—With oiled silk make a model of the flap required. Figs. 266 to 273 represent variously shaped flaps which have been used.

Step 1.—Place the anesthetized patient in the Rose or Trendelenburg posture. Thoroughly freshen the edges of the nasal defect down to, but not beyond, the points into which the new alæ of the nose are to be inserted. When

considerable skin exists over the bridge of the nose, Step 1 may be modified advantageously as follows: From the nasal bridge reflect the flap of skin A, B, C (Fig. 292) and turn it down with its epidermal surface directed towards the nasal cavity. Freshen or pare the edges of the nasal defect as already described. When in Step 3 the forehead flap is turned down, its raw surface lies in contact with the raw surface of the flap from the nasal bridge, an epidermal lining is provided for the new nose, and thus shrinking is obviated.

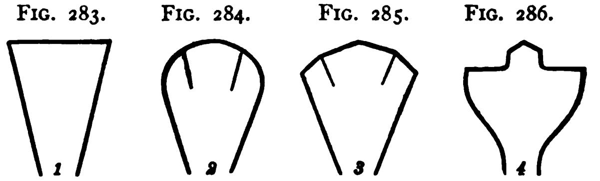
FIG. 281.

FIG. 282.

FIGS. 281 AND 282.—Hueter's operation. (*Esmarch and Kowalzig.*)

Step 2.—Place the oiled silk model on to the forehead, in an oblique position, and with its pedicle so placed as to include the angular artery. Guided by the model as to shape and size, cut a flap from the forehead. The flap consists of all the structures down to the bone. With sutures lessen the size of the defect left in the forehead; cover such open wound as may be left with skin-grafts.

FIG. 283. FIG. 284. FIG. 285. FIG. 286.



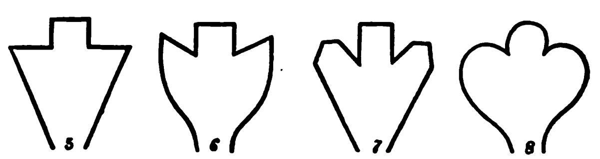


FIG. 287. FIG. 288. FIG. 289. FIG. 290.

FIGS. 283 TO 290.—(*Esmarch and Kowalzig.*)

Step 3.—Turn the forehead flap downwards with its epidermal surface forwards, being careful not to twist the pedicle too severely. As this step is being carried out it may be necessary to lengthen the lateral incisions which bound the pedicle. Fig. 291 shows a well-designed pedicle. Attention to the pedicle is of prime importance because too great torsion means interference with the blood-supply, and more particularly with the drainage of the flap. It is wise to make numerous shallow scratches through the epidermis of the flap; these permit of lymphatic drainage. (See chapter on Plastic Operations.)

Fold on itself, laterally, that portion of the flap which is to form the new septum of the nares and maintain this fold by one or two stitches (Fig. 293). Fold on themselves the two lower angles of the flap which are to form the alæ of the nose and maintain the folds by means of mattress sutures.

Step 4.—Suture the raw edges of the new alæ of the nose into their proper position in the nasal defect. Do the same with the new nasal septum. Suture

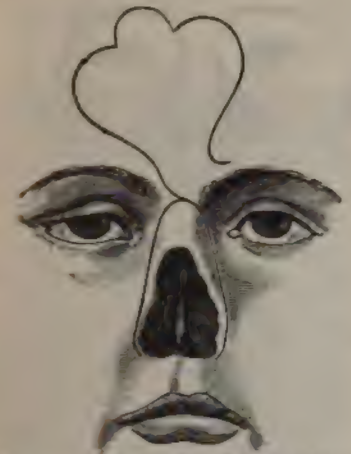


FIG. 291.—(*Esmarch and Kowalzig.*)

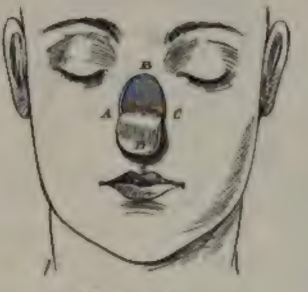


FIG. 292.

FIG. 293.

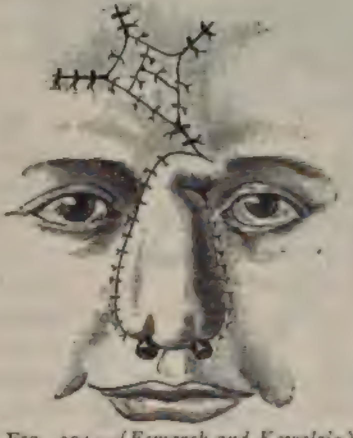


FIG. 294.—(*Esmarch and Kowalzig.*)

the rest of the flap in position (Fig. 294). Do not use too many sutures near the pedicle, and in attempts at esthetic effect do not jeopardize the vitality of the flap, which depends on the freedom of the pedicle. If the flap lives and unites in its new position, any defects in the appearance of the root of the nose may be safely attended to subsequently. Keep the newly formed nasal openings patent by means of dressed rubber tubes or cigarette drains.

2. **French Method.**—In this operation pedunculated flaps taken from the cheeks are used to repair nasal defect. Figs. 295 and 296 sufficiently describe the operation as performed by Nélaton.

3. **Italian Method.**—Skin for the repair of the nasal defect is obtained from the anterior and inner aspects of the upper arm.

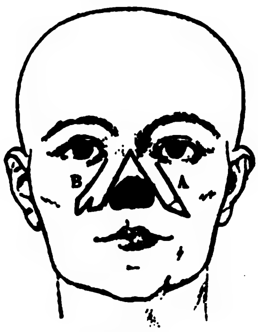


FIG. 295.

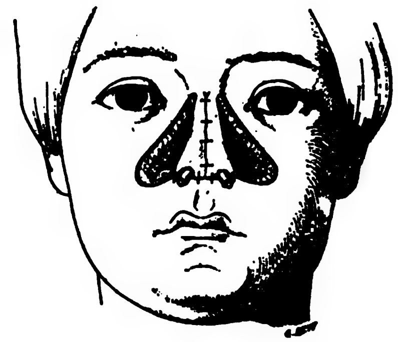


FIG. 296.

FIGS. 295 AND 296.—(*Monod and Vanverts.*)

Step 1.—Dissect from the upper arm a flap of skin, with its pedicle pointing towards the elbow. Flex the shoulder and bring the free end of the flap in contact with the vivified edges of the nasal defect. Unite the flap to the nasal defect by means of sutures. With suitable apparatus (Fig. 297) fix the head and arm so that they maintain a constant relationship to each other until union has taken place.

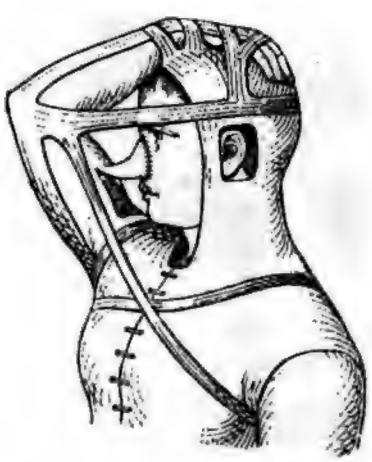


FIG. 297.—(*Monod and Vanverts.*)

Step 2.—When the flap is firmly united to the edges of the nasal defect, divide its pedicle and complete the rhinoplasty by forming the alæ and septum of the nose out of the lower portion of the flap.

II. The destruction of tissue involves both the soft parts and the osseous and cartilaginous supports of the nose.

A. The tip of the nose with its alæ and septum are intact [König (see p. 200), Israel (see p. 201)].

B. The tip of the nose has been destroyed.

Finger Operation.—The bony framework of the nose is absent and the soft structures are more or less destroyed (Fig. 298).

1. By paring and splitting the tissues, vivify the edges of the nasal defect. Preserve as flaps all tissues which may be of use in forming the new nose. Vivify the bone at the root of the nose. Apply warm gauze to the wounds.

2. A. Make an incision through the skin on each side and the whole length of the middle finger of the left hand, carefully avoiding injury to the vessels.

Reflect the skin forwards on the palmar side of the wounds for a short distance so as to form a skin flap on each side of the finger. These flaps are reflected *only* from the sides of the finger; the skin on the palmar surface of the finger is left intact. Form similar flaps on the dorsal side of the wounds. Through the original incisions excise the carpo-phalangeal articulation and divide the flexor and extensor tendons as well as the ligaments of the excised joint, being careful *not* to injure the vessels. Excise the finger nail. Remove the skin from the tip of the finger. Cut off the distal end of the last phalangeal bone.

FIG. 298.—(*McWilliams.*)

FIG. 299.—(*McWilliams.*)

B. If there is a sufficiency of suitable tissue at the nasal defect to form an epithelial lining for the new nose then, instead of the lateral incisions on the finger, make one median incision and from it reflect flaps of skin towards the sides of the finger.

3. Apply the cut surface of the bone of the distal phalanx to the vivified bone at the root of the nose and fix it there with sutures.

A. If method A has been adopted in step 2, suture the palmar flaps, with their epidermal surfaces directed towards the nasal cavity, to the deeper parts of the skin flaps around the nasal defect. This forms an epithelial lining to the new nose. Suture the dorsal flaps to the edges of the skin flaps around the nasal defect (Fig. 299). Support and immobilize the hand, arm and head with plaster of Paris as shown in Fig. 301.

B. If method B, step 2, has been adopted, use the remnants of tissue around the nasal defect to form the epithelial lining for the new nose and cover with the skin of the finger.

4. After about two or three weeks ligate the vessels on one side of the base

of the finger through the existing lateral incision; a few days later ligate the vessels on the other side of the finger (McWilliams).

5. About four or six weeks after the first operation amputate the finger at the base of the first phalanx. Trim the phalanx suitably, flex it and suture its raw end to a bed prepared for it at the middle of the lower edge of the nasal defect so that it now forms the columella.

As some necrosis of the proximal phalanx often occurs after amputation it may be wise to defer trimming and implanting it in the nasal defect until viability is assured (Fig. 302).

6. After healing of the implants is complete it may be necessary to perform a number of minor plastic operations to make the new prominence or proboscis

FIG. 300.—(*McWilliams.*)

FIG. 301.—(*McWilliams.*)

approximate the form of a human nose. Figs. 298 and 299 show a patient of McWilliams before and after operation. Fig. 300 shows the position of the phalanges in the same patient.

Nélaton's Operation.—Ch. Nélaton has devised an ingenious method of rhinoplasty which requires no description other than that afforded by Figs. 303, 304, 305, 306.

Ch. Nélaton's Operation with Transplantation of Costal Cartilage.—*Preliminary Operation.—Step* 1.—With oiled silk make a model or pattern of the flap necessary to cover the new nose with skin. Lay the model on the forehead and mark its outlines with silver nitrate. The best shape and position for the flap are shown in Fig. 307.

Step 2.—Without injuring the perichondrium excise by sharp dissection the whole cartilage of the eighth rib. Close the wound. With a knife pare about one inch of one end of the cartilage (the rib end) until it is not more than 1/8 inch (3 mm.) thick. This thin portion is destined to form the new column of the nose. Where the pared portion of cartilage joins the unpared portion cut a notch nearly through the cartilage so that it may be later bent in fashioning the nose.

Step 3.—At the middle of the distal end of the flap outlined with silver nitrate on the forehead, make a cut down to the bone. With a director burrow a tunnel under the periosteum from end to end of the flap (Fig. 307). Pass the graft of cartilage into this tunnel in such fashion that its thin or pared-

FIG. 302.—(*McWilliams.*)

end lies subperiosteally near the skin wound and the notch at the junction of the pared and unpared portions faces towards the skin. Close the skin wound. Apply dressings.

After about two months the second stage of the operation may be undertaken.

Second Stage in the Operation.—Step 1.—Make an incision all round the nasal defect except at its lower side (Fig. 307). This cut penetrates to the bone. Reflect the soft parts between the incision and the nasal defect towards the latter (Fig. 307).

Step 2.—Reflect the flap which was outlined on the forehead at the preliminary operation. (Of course the original marking has disappeared but the model has been kept and the flap has been again traced out with silver nitrate.) The implanted cartilage is an integral part of the flap. Model the distal end

of the flap as in Figs. 293 and 308. Gently twist the flap into position and fix it by sutures as shown in Fig. 294.*

Schimmelbusch's Operation.—Practically as in the Indian method, make a forehead flap to cover the defect in the nose, but here the flap consists of the

FIG. 303.

FIG. 304.

FIGS. 303 AND 304.—Nélaton's operation. (*Monod and Vanverts.*)

FIG. 305.

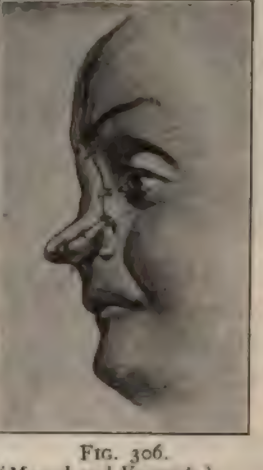


FIG. 306.

FIGS. 305 AND 306.—Nélaton's operation.—(*Monod and Vanverts.*)

outer table of the skull as well as skin (Fig. 309). Protect the flap with gauze and close the forehead defect, preferably by sliding forwards and inwards large flaps of the scalp, as shown in Figs. 309 and 310. Examine the reflected flap of bone and skin. If the bone is not splintered, cover the whole raw surface at

* In Fig. 294 the flap has been taken from a different part of the forehead

ice with Thiersch's grafts, protect the grafts with silver-foil or rubber tissue, nd apply gauze dressings. With bandages support the flap against the head and ait until the grafts have become mature. This period of waiting is of value that the flap becomes accustomed to receiving its nourishment through the edicle before the pedicle is disturbed by twisting, but as the flap inevitably hrinks during the delay, it is very necessary that it be made at least one-sixth arger than the defect to be filled. If on examination the bone in the flap is

FIG. 307.

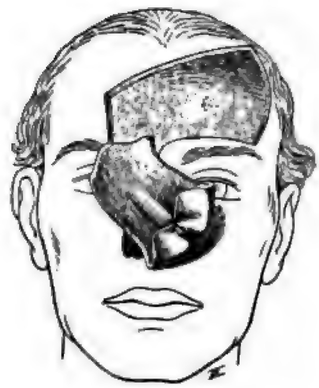


FIG. 308.

FIGS. 307 AND 308.—Nélaton's operation. (*Laurens.*)

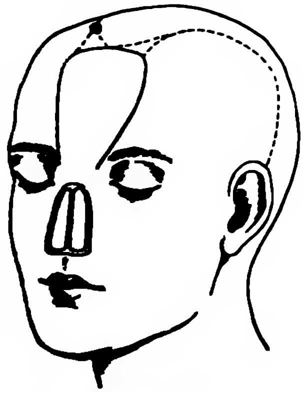


FIG. 309.

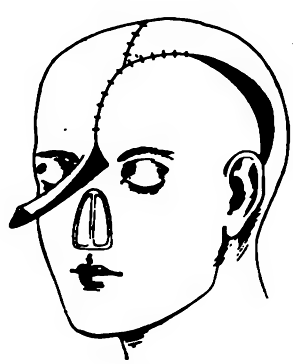


FIG. 310.

FIGS. 309 AND 310.—Schimmelbusch's operation.

found to be splintered, delay the skin grafting until any necrotic bone is thrown off and the remainder is covered by granulations (four to eight weeks). When the raw surface of the flap is satisfactorily covered with epidermis, making an incision with a fine saw in the middle line through the bone in the flap, so that the flap can now be bent into a Λ shape (Fig. 310). Mobilize the pedicle of the flap and twist the latter into position. With sutures unite the edges of the flap to the freshened edges of the nasal defect. When freshening the edges of the

nasal defect, it is easy to form flaps of tissue which may be used to form a septum for the nostril (Fig. 311).

E. Lexer's Operation.—As Schimmelbusch's operation is based on König's so is Lexer's on Schimmelbusch's. Lexer ("Archiv für klin. Chir.," xcii, 749) recognizes that after complete rhinoplasty it is most difficult to breath through the nose because of contraction of scar tissue. Before operation the disease causing the deformity (syphilis, tuberculosis) has caused much destruction of tissue and recovery has taken place by the filling in of ulcerations and defects with granulation tissue which has contracted until the pyriform opening has become small and distorted and nasal respiration is poor. Before attempting to form a new external nose the freedom of the air passage must be assured. The operation is performed in many stages.

FIG. 311.

First Stage.—Step 1.—With knife, scissors and chisel cut away all scar tissue which deforms the pyriform opening and obstructs respiration.

Step 2.—From the skin around the opening, from remnants of the alæ of the nose, etc., from pedunculated flaps and with these cover the defects resulting from the excision of scar tissue (Fig. 312). These flaps may be held in place by gauze tampons until they become united to their new beds. *No* flaps may be taken from the root of the nose above the aperture; the skin here must be preserved intact for use later.

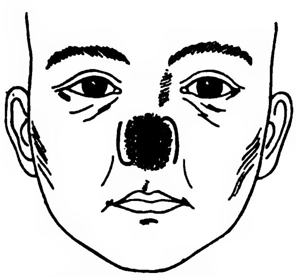


FIG. 312.—(*Lexer.*)

FIG. 313.—(*Lexer.*)

Second Stage—Preparation of Flap from Forehead.—This procedure is identical with that of Schimmelbusch except that Lexer at once covers the bone in the flap with skin by folding the flap on itself (Figs. 313 and 314). The wound in the forehead should be covered by Thiersch or Wolf skin grafts.

Third Stage.—(Three or four weeks later.) *Step* 1.—*Formation of pedicle for the forehead flap.*

The flap on the forehead formed in stage 2 was provided with a broad pedicle whose base was on a level with the eyebrows (Fig. 313). Lexer, in several sittings, gradually step by step continues the cuts which outline the

forehead flap downwards until they reach on one side the inner angle of the eye, on the other side the nasal opening (Fig. 315). From the latter incision he separates the skin of the root of the nose from the bone until the middle line is reached (Fig. 299) and it becomes possible to twist the pedicle and bring the flap into position without tension.

Step 2.—From the under surface of the forehead flap reflect a narrow flap of skin to form the septum or philtrum of the new nose (Fig. 316) and through

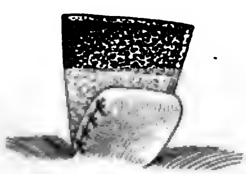


FIG. 314.—(*Lexer.*)

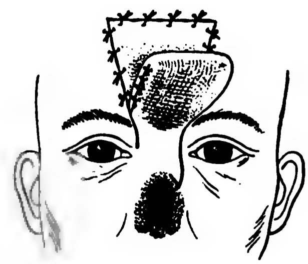


FIG. 315.—(*Lexer.*)

the wound thus made divide the bone in the flap longitudinally so as to fold the bone on itself as in Schimmelbusch's operation.

Step 3.—Freshen the edges of the nasal aperture and suture the forehead flap in proper position as in Schimmelbusch's method.

Fourth Stage.—After several weeks divide the pedicle using its remnants to help to repair the defect between the eyebrows. It is better to delay this step as long as possible, as when the pedicle is divided the transplanted bone may atrophy, especially in syphilitics.

FIG. 316.—(*Lexer, Archiv. für Klin. Chir.*)

The result of the operation so far is to provide the patient with a hideous excrescence which an Ananias or an enthusiast might call a nose. Lexer next proceeds to fashion a nose from the excrescence.

Fifth Stage.—This stage [illegible] a few weeks after the pedicle has been divided.

[illegible] *of a D*[illegible] *en the Forehead and the Nose.*—At the [illegible] *divid*[illegible] front of the angle of the eye, down to the

bone excising any disfiguring scar tissue. The cuts made for this purpose are about 2 cm. long. From these cuts on each side separate the soft parts from the bone and cut away all œdematous and thickened connective tissue (Fig. 317, b).

The subcutaneous excision of scar tissue leaves a superfluous amount of skin and hence it is necessary to convert the lateral linear incisions into ellipses (Fig. 317, b) by excising a little skin from their anterior margins before closing them with sutures.

2. *Formation of the Point of the Nose.*—The tissues about the point of the nose have sunk down and are too voluminous.

On the under surface of the new nose make a semilunar incision which reaches near the base of the *septum nasi* already constructed (Fig. 318, a).

a b c d

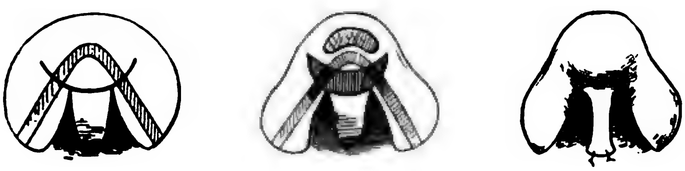
FIG. 317.—(*Lexer.*)

Through this incision pass an elevator and raise the skin of the tip of the nose from the underlying bone (obtained from the forehead). Obtain a fresh piece of bone from a rib or tibia of the same patient or from some other person who has required an amputation or resection. Model this fragment of bone into an oval with a shallow groove on its *non*-periosteal side and with somewhat of a convexity on its periosteal side. Push this fragment into the bed prepared for it at the tip of the nose, periosteum towards the surface, in such a manner that it lies, subcutaneously, on the bony support of the new nose and forms a rounded tip to it. The pushing in of the fragment of bone makes the semilunar incision gape somewhat but this open wound will heal by granulation satisfactorily (Figs. 317, c, and 318, b and c). For a few days it may be necessary to leave a pin *in situ* perforating the fragment of bone and keeping it from being misplaced.

3. *Formation of the Alæ of the Nose.*—The curved incision used for the implantation of bone to form the point of the nose in healing contracts and

small notch which when seen from the side acts as an anterior margin ower edge of the alæ. To make this notching more distinct and to ıe clumsy lower edge of the new nose thinner, subcutaneously excise the curved incision, the soft tissues on the inner side of the bony of the nose and with fine forceps cut out a notch in the bone on each as to widen the nostrils (Figs. 317, c, and 318, b). Last of all fashion er side of the alæ by excising a small amount of skin as in Fig. 317, d, suturing this wound stitch its posterior cutaneous edge *not* to its anterior *us* edge *but* to the subcutaneous tissue in front of the wound, thus ng a more or less sightly indentation.

The destruction of tissue involves only the osseous and cartilaginous ork of the nose, the surface being left intact.



a b c

FIG. 318.—(*Lexer.*)

nney's Operation.—*Step* 1.—Cut away the nail and its matrix from the inger of the left hand. Remove the skin from the back of the finger its middle joint. Denude the tip of the finger completely, leaving the f the bone bare. Stop bleeding.

tep 2.—Introduce a tenotome into the nose and divide all the cicatricial ections between the retracted tip of the nose and the frontal and superior illary bones. Pull the soft parts of the nose forwards into the best possible ition. Do not cut the skin. Vivify the inner surface of the dorsum of the se in the middle line.

Step 3.—Introduce the prepared ring finger into the nose in such fashion at the tip of the exposed phalanx lies in contact with the nasal process of frontal bone and the raw surface of the dorsum of the finger is in contact h the raw median surface of the inside of the dorsum of the nose. Hold finger in position with stitches uniting the edges of the finger wound to ree border of the tip of the nose.

p 4.—Hold the hand in position by means of adhesive strips and plaster s for two weeks.

5.—(Two weeks later). Disarticulate the finger at the metacarpo-eal joint. Apply dressings.

6.—(One week later than Step 5). Split the tissues in the middle the nasal spine of the superior maxilla. Flex the finger at the proximal Insert the free end of the proximal phalanx into the wound l spine of the superior maxilla and fix it there with sutures. halanx forms the column of the nose; the two other pha-

langes form the dorsal support. Later some minor operations will be necessary to narrow the new column of the nose and to improve appearances.

König's Operation.—This operation was originally devised for the correction of saddle-nose, but it is also of great value in the treatment of cases where the soft parts are absent as well as the hard. The operation as here described is that done for saddle-nose; the modifications required when the soft parts are absent are so self-evident that they will not be mentioned.

Step 1.—Make a transverse incision across the seat of the saddle (A, B, Fig. 319). Pull the tip of the nose down into correct position.

Step 2.—From the forehead turn down the vertical flap D (Figs. 320 and 321) and suture its free extremity to the point C at the tip of the nose. This

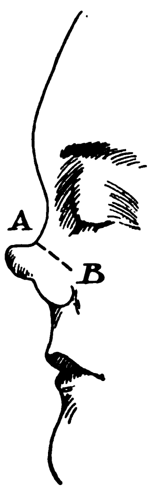


FIG. 319.

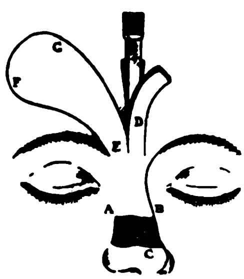


FIG. 320.

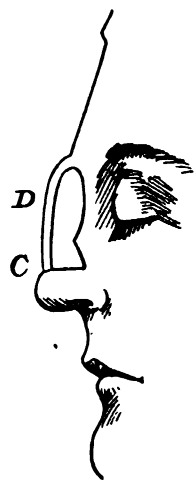


FIG. 321.

FIGS. 319, 320 AND 321.—König's operation.

flap is ½ inch wide and is made by cutting through the soft parts with a knife, introducing a chisel through the upper part of the wound, and thus elevating a long narrow strip consisting of skin, periosteum, and the outer table of the skull. The bone in the flap gives firmness to the new nose.

Step 3.—After the Indian fashion, reflect from the forehead, a skin-flap, E, F, G (Fig. 320), and turn it down so as to cover the nasal defect A, B, C (Figs. 320 and 321), as well as flap D.

The results obtained from this operation or some of its modifications have been very satisfactory.

Author's Method.—This is suitable in cases where the nasal bones and the surface structures are intact but all the cartilaginous septum has been destroyed.

Step 1.—Without injuring the perichondrium excise by sharp dissection thin strips of cartilage from eighth rib. The strips should be about 1½ inches long, ¼ inch wide and ⅛ inch thick. Preserve these in warm salt solution. Close the wound.

Step 2.—With a tenotome introduced either through the skin or, as in Finney's operation, through the nose, divide the cicatricial connections of the nose to the pyriform aperture. Pull the nose forwards into as good position as possible.

Step 3.—Introduce a tenotome through the skin in the middle line of the nose just below the osseous nasal bridge. From the puncture make a tunnel between the skin and the mucosa on each side down to the junction of the nasal alæ and the upper lip, where the skin is again perforated. With an eyed probe or a forceps pull a thread and by means of the thread pull a strip of cartilage through each tunnel. Do not permit the ends of the cartilage to protrude through the skin punctures. The strips of cartilage act as splints or braces for the nose. Of course it is easy to introduce a strip of cartilage at any place where it will do most good.

Israel's Operation.—This is merely a modification of König's method, but gives better cosmetic results. The flap D (Fig. 321) is made narrow, being only about 1/8 inch wide, and when turned down and its free end sutured in place, exactly as in König's operation, it is left uncovered by any other flap. After a short time the raw surface of the flap becomes covered by granulation tissue and the epidermis spreads over it. The local condition is now the following.

The tip of the nose is in normal position. The skin and bone flap D (Fig. 321) bridges over the defect created by the incision A, B (Fig. 319), and also the undivided skin at the root of the nose. Whenever flap D has become well healed, draw it slightly to one side; make a vertical median incision through the skin at the root of the nose above the defect. Elevate this skin on each side of the median incision, bring the edges up, and suture them to the vivified edges of the new nasal bridge (flap D, Fig. 321).

Von Mangold's Operation.—*Step* 1.—Make a small transverse incision across the middle line through the skin at the glabella. With a Kocher sound or blunt dissector burrow a tunnel under the skin, in the middle line down to the point of the nose.

Step 2.—Expose by incision the seventh or eighth costal cartilage. Excise a plate of cartilage, with its perichondrium, about 1 3/4 inches long, 3/8 inch wide, and 1/8 inch thick.

Step 3.—Push the excised plate of cartilage into the subcutaneous tunnel prepared on the nose. The side of the graft which has no perichondrium ought to be directed towards the skin. Close the little wound with sutures.

Step 4.—Make a small incision through the skin in the grooves to the outside of each ala of the nose. Through these incisions implant a thin strip of costal cartilage in each ala.

Von Mangold was able to form good nares, to correct saddle shape and to obtain a rectilinear nose, but it was necessary to lengthen and improve the shape of the organ at a second operation after an interval of five months.

Second Operation.—Through an inverted **V**-shaped incision (apex of **V** in middle line at root of nose, legs of **V** coming down on each side of the nose) detach the soft structures of the nose and with them the cartilaginous graft,

FIG. 322.—(*Marshall, Journ. A. M. A.*)

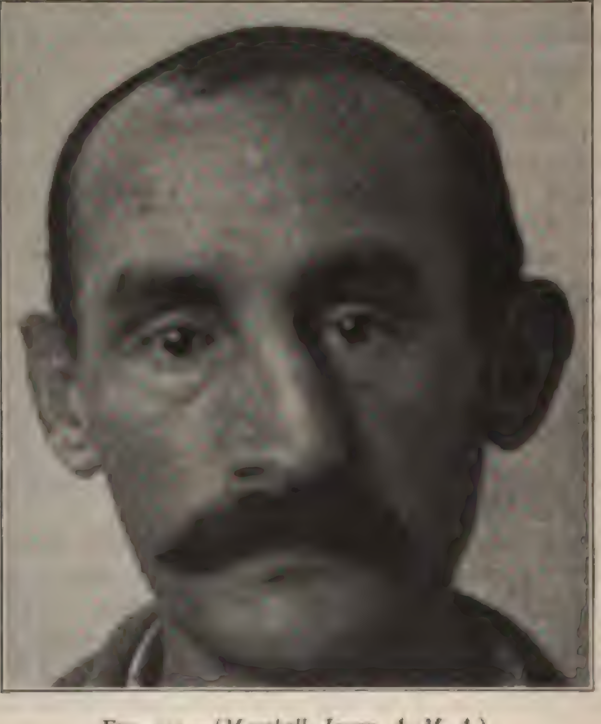


FIG. 323.—(*Marshall, Journ. A. M. A.*)

from the subjacent structures. Carefully apply the upper end of the graft of cartilage into the angle between the glabella and the root of the nose. Suture the wounds.

External lateral deflections of the nose commonly the result of accidents or blows are often so disfiguring as to interfere seriously with the bearer's chances of earning his livelihood.

Marshall's Operation.—("Journ. A. M. A.," Jan. 18, 1913.)

Step 1.—With a tenotome puncture the skin over the nasal process of the superior maxilla where the elevation which makes the nasal prominence begins. Introduce a chisel about 1/16 inch wide, through the puncture, and divide the

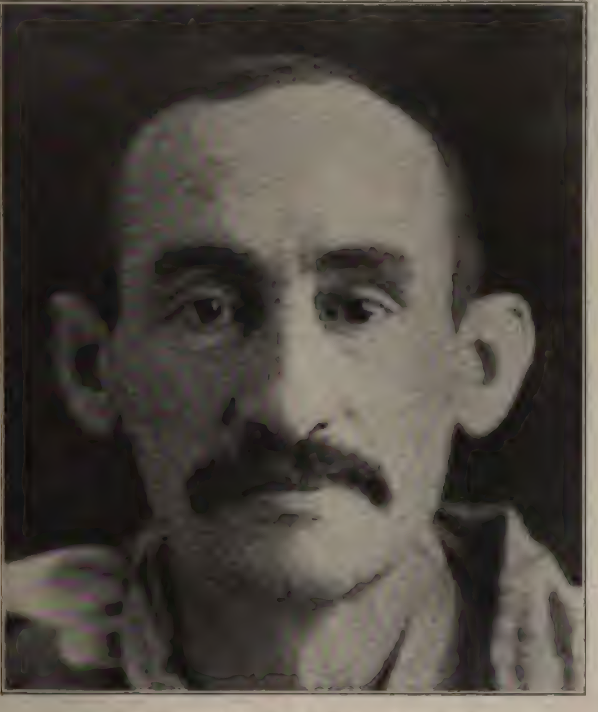


Fig. 324.—(*Marshall, Journ. A. M. A.*)

process *without* injuring the nasal mucosa (Fig. 322). The division of bone may be accomplished as widely as necessary without enlarging the skin incision. Apply pressure to the wound for purposes of hemostasis.

Step 2.—Do the same on the opposite side.

Step 3.—Introduce one blade of an Ashe septal forceps (better a heavier forceps with longer blades) into the nares, the other blade being outside, and complete by fracture the mobility of the nasal process along its entire line, for the upper part of the nasal process can usually be made mobile at the sutures along the lacrimal and the nasal bones on the corresponding side.

Step 4.—Do the same on the opposite side.

Step 5.—If there is a nasal obstruction through malposition of the septum, seize the septum with the same forceps and force it into correct position.

Step 6.—If the nose is not yet straight the defect probably lies at the suture between the frontal and upper extremities of the two nasal bones and both processes of the superior maxilla. Straighten this faulty angle "by a sharp stroke with the mallet at this point guarded by a rubber-covered lead plate, the force being directed downwards from the frontal bone, but towards the obtuse angle (that is, against the deflected side). Elevation can be assisted sometimes to advantage with a large urethral sound."

Step 7.—Dress the wounds with collodion. Occasionally Marshall inserts nasal splints for 24 hours. The nose ought to remain absolutely straight without being held in position. Do not use apparatus to hold the nose in position, such is uncomfortable and gets out of place to such a degree as to do more harm than good. Marshall instructs his patients to keep a moderate pressure on the originally deflected side for several days so as to obviate any tendency to recurrence of the deformity. Figs. 323 and 324 show a patient before and after operation.

CHAPTER XIX

›RTICOLLIS. WRY-NECK. CAPUT OBSTIPUM

several methods of operating on torticollis.

taneous tenotomy of the sternal and clavicular portions of the . This operation is rarely performed, as its only advantage ›sence of scar, while its disadvantages are danger and incom-

section of the same structures, *plus* division of all bands of fibrous obstruct reduction of the deformity.

on lengthening.

ion of the degenerated sternomastoid (Mikulicz).

e torticollis is of the spasmodic variety, the following methods dvised:

sion or excision of the spinal accessory nerve.

tiple myotomy (Kocher).

enotomy of Sternomastoid.—The favorite site for dividing the ½ to ¾ inch above the clavicle. The skin incision may be vertical, transverse; probably the oblique is best. Beginning at the outer sternal attachment of the sternomastoid, make an incision 1 to 1½ ength, passing upwards and outwards to the middle of the anterior the clavicular portion of the muscle. Retraction of the wound ex- portions, which are easily isolated and divided without danger to other Rotate the head firmly towards the sound side, keeping the shoulder ted side steady. This manœuvre puts all other contracted structures ch. Divide all such, even down to beside the carotid packet of end carefully to hemostasis. Suture. Dress. Lorenz advises orrection before the patient comes out of the anesthesia. The vercorrected position must be retained either by an extension means of a proper collar.. After healing has taken place, massage, r a time, the use of some orthopedic apparatus, such as Sayre's

hening.—Thelwell Thomas ("Lancet," March 9, 1912) has ults by muscle lengthening. It does away with long and tire- ent as he does not use any retentive apparatus. Make a a over the lower third of the sternomastoid. Expose the isolate a sufficient segment of it. Estimate how much the horter than its fellow. Split the affected muscle longitudi- ual to a little more than half the amount of the shortening. the vertical incision divide the anterior portion of the At the upper end of the vertical incision divide the pos-

terior portion of the muscle. Suture the ends of the muscle with chromicized catgut. Close the wound. It is often necessary to divide bands of deep fascia as well so as to obtain correction.

Myomectomy.—*Mikulicz's Operation.*—In severe cases of torticollis Mikulicz advises excision of the lower two-thirds of the sternomastoid, the upper one-third being preserved so as to avoid injury to the spinal accessory nerve.

Expose and divide the sternal and clavicular portions of the muscle as in open tenotomy. Seize the divided ends in forceps and pull the muscle downwards and through the skin-wound; as this is done, separate it from its surroundings by blunt and sharp dissection. Avoid injuring the external jugular vein. When two-thirds of the muscle is isolated, divide and remove it. Attend to hemostasis. Divide all cicatricial bands which can be felt. Close the wound. Apply dressings and pressure enough to obviate dead spaces. No subsequent orthopedic treatment is required.

Bruns in doing this operation removes only one-third of the muscle. The chief disadvantage of the operation is cosmetic, viz., the loss of the shapeliness of the neck. It should be reserved for severe or recurrent cases.

Division of the Spinal Accessory Nerve.—The spinal accessory nerve escapes from the skull through the jugular foramen. It runs obliquely downwards and backwards between the internal jugular vein and the digastric muscle, entering the sternomastoid muscle at a point about two inches below the mastoid process. The nerve pierces the muscle obliquely and proceeds across the posterior triangle of the neck to supply the trapezius.

The Operation.—Make an incision 2½ to 3 inches in length from the mastoid process downwards along the anterior border of the sternomastoid. Expose the anterior border of the muscle and divide the cervical fascia. Retract the muscle backwards. With the finger recognize the transverse process of the atlas, which is covered by the digastric muscle. The nerve, after passing between the bony process and the muscle, emerges at the lower edge of the latter and passes to the sternomastoid. Expose the nerve and either divide it or excise about ½ inch of it. Close the wound with sutures. Dress. The results of the operation are usually good; the danger is practically *nil.*

Nerve Section for Spasmodic Torticollis.—Division of the posterior primary divisions of the cervical nerves was first carried out by Gardner of Adelaide and Keen of Philadelphia in 1888. The operation is only suitable for very severe cases in which the disease has rendered life a burden. The object of the operation is to paralyze all the muscles involved—*e.g.*, when the spasm turns the head to the right and extends it one should paralyze the *left* sternomastoid and trapezius and the right splenius capitis, trachelomastoid, superior and inferior oblique, rectus capitis, posticus major, complexus and trapezius.

Robert Kennedy ("Brit. Med. Journ.," Oct. 3, 1908) has endeavored to simplify the exposure of the nerves, no easy matter at the best.

Step 1.—Make a vertical skin incision from ½ inch above the superior curved line downwards for 3 to 3½ inches midway between the external ear and the external occipital protuberance.

Step 2.—Define the posterior edge of the sternomastoid and deepen the incision behind the sternomastoid until the oblique fibres of the splenius capitis are exposed. Do not injure the spinal accessory nerve which may lie near the lower angle of the wound.

Step 3.—Define the upper border of the splenius capitis and divide that muscle in the line of the original incision. Divide the subjacent connective tissue exposing, above, the complexus whose fibres run longitudinally, and below, the trachelomastoid whose fibres run obliquely.

Define the outer edge of the complexus and the upper edge of the trachelomastoid.

The upper part of the wound is crossed by the occipital vessels. Deep down in a triangle formed by the occipital vessels and the two muscles lies the superior oblique muscle.

Step 4.—Follow the outer border of the complexus to its highest slip of origin (third cervical articular process). Detach this slip from the bone. Repeat this with the slip originating from the fourth articular process. Retract the trachelomastoid outwards. Fold the complexus inwards and so expose several nerves entering its deep surface. "The largest is the great occipital or internal branch of the posterior primary division of the second cervical and this pierces the complexus about the level of the lower edge of the lobe of the ear. Above the point at which the great occipital enters the complexus a slender branch can be seen entering the muscle and it can be traced back to the posterior primary division of the first cervical nerve. The latter, however, is best found by tracing out the slender branch of communication with the second posterior primary division which as a rule is present, passing upwards from the second division across the inferior oblique. It is very difficult to deal satisfactorily with the suboccipital nerve unless this communicating branch is early found and traced upwards at once to the first division which lies between the vertebral artery and the arch of the atlas, and, of course, the operation is only imperfectly performed unless the first division is adequately dealt with. A short communicating branch leads from the second division down to the third division and is a safe way of reaching the latter. The fourth and fifth divisions can be easily found passing downwards and backwards close to the vertebræ. The nerves, from the second downwards, should be isolated to the point of separation into anterior and posterior primary divisions, but not further, and undue traction can quite easily pull the anterior primary division backwards and expose it to the danger of being damaged. The first nerve is sectioned just proximal to its branches, and the others near their point of separation from the anterior primary division. In the great majority of cases the nerves once sectioned are excised from the point of section as far distally as can be reached."

Step 5.—The nerves having been exposed excise a segment of each. Do *not* stretch the nerves lest rupture of the roots occur and paralyze the anterior primary divisions. Resection of the nerves means total and permanent paralysis of the muscles involved. Kennedy suggests another method of operation

in cases where the spasm, though very violent, has not been of long standing, and which refuses to yield to any known treatment short of operation. In such acute cases, *i.e.*, where the affection has lasted only a few months and there seems hope of cure, Kennedy gives the muscles rest by *dividing* and *immediately suturing* the spinal accessory of one side and the posterior primary divisions of the opposite side. "The result is that the violent spasm is immediately abolished, the affected muscles degenerate, and in the course of some weeks, after the nerves have regenerated, as indicated by the gradually returning sensation, the muscles begin to get built up again and shortly begin to resume their functions."

Multiple Myotomy.—*Kocher's Operation.*—Two incisions are necessary.

1. Make an incision 1¼ to 1½ inches in length along the anterior border of the sternomastoid, commencing opposite the angle of the jaw and passing upwards. Divide the platysma and if possible save the external jugular vein. Open the sheath of the sternomastoid along its anterior border. Introduce a blunt dissector under the muscle and divide it layer by layer. Attend to hemostasis. Close the wound with sutures. If desired, the spinal accessory nerve may be stretched or divided during this procedure.

2. The patient is turned on to his sound side. Beginning at the mastoid, make a transverse incision backwards. Through this divide the trapezius transversely and incise the splenius capitis and complexus muscles. Avoid injuring the great occipital nerve, which here traverses the complexus and trapezius. The inferior oblique muscle arises from the spinous process of the axis and is inserted into the transverse process of the atlas. Look for this muscle in the space between the atlas and axis and divide it. Attend to hemostasis. Close the wound.

Monod and Vanverts write as follows: "Section should be made of the muscles which participate in the spasm. It is necessary, by analysis, to determine prior to operation the muscles involved. One may be compelled to practise, according to the case, the following operations: division of sternomastoid and of the muscles of the nape of the neck on the opposite side (typical rotary tic); division of the sternomastoid and of the muscles of the nape of the neck on the same side (rotary tic with predominance of lateral deviation); division of sternomastoid and bilateral division of the muscles of the nape of the neck (rotary tic with much posterior extension)."

Remarks.—In some cases of torticollis no operation seems to be effectual; such are usually due to affections of the posterior nerve and muscle groups. Extirpation of the nerves involved has been advised, but this is a very complicated, and for most surgeons inadvisable operation, and is not a glittering success.

In other cases any operation involving tenotomy is successful. When the muscle is greatly degenerated and adherent, Mikulicz's procedure is the best. In spasmodic varieties of torticollis section of the spinal accessory nerve is the operation of choice.

CHAPTER XX

EXCISION OF CERVICAL RIBS

Excision of Cervical Rib.—Cervical ribs vary much in size and may be unilateral or bilateral. They articulate with the seventh cervical vertebra and may end as a longer or shorter process lying among the tissues of the neck or their anterior end may be united to the first thoracic rib or to the sternum. Commonly no symptoms are produced, but sometimes the rib exercises pressure on the vessels or on the nerve trunks passing over it or on both. When these symptoms are severe and do not give way to conservative treatment, operation becomes necessary. Occasionally the rib itself is short but is continued forwards as a strong band of connective tissue and this band exercises pressure and gives rise to trouble. In such a case excision of the connective-tissue band is of course the proper treatment.

A. Operation from in front. *Step* 1: *Incision.*—Numerous incisions have been devised: (*a*) Transverse, a finger's breadth above the clavicle reaching from the sternomastoid to the trapezius. (*b*) Oblique, along the anterior edge of the trapezius or a half inch in front of it. (*c*) Vertical over the most prominent part of the swelling caused by the rib. One incision is as good as another provided that free access is secured; sometimes it is necessary to combine two incisions so as to obtain room.

Step 2.—Divide the platysma and superficial fascia, doubly ligating and dividing the external jugular vein. Divide the deep fascia. Penetrate the underlying loose, vascular fatty tissue so as to expose the great vessels and the brachial plexus. Cautiously retract the vessels and nerves from over the cervical rib.

Step 3.—By blunt and sharp dissection separate from the rib the soft parts attached to it. Great care is necessary to avoid injuring the pleura which may be attached to the rib. The danger of pleural puncture has been much exaggerated. Subperiosteal resection of the rib is easier than extra-periosteal but one or more cases have been reported in which a secondary operation was required owing to reformation of the rib. At first expose and isolate a small median portion of the rib. From this as a starting-point follow the rib towards the spine and divide it with bone forceps, being careful to leave no sharp spicules protruding from the stump left attached to the spine. Follow the rib to its anterior attachments and divide them. Remove the rib. If complete excision is very difficult or risky it *may* occasionally be wise to resect merely that portion of the bone which is exercising injurious pressure on the vessels and nerves.

Step 4.—Attend to hemostasis. Close the wound with deep and superficial sutures.

B. Operation from behind. (Streissler's method.) From a point ¾ inch (2 cm.) lateral to the spinous processes of the vertebræ and one hand-breadth above the vertebra prominens make an incision downwards parallel to the spine to a point one hand-breadth below the vertebra prominens. Divide the trapezius, both the rhomboids, serratus posticus and splenius; separate the fibres of the complexus and semispinalis colli. Expose the transverse processes of the two lower cervical and two upper thoracic vertebræ. The articulation between the cervical rib and the transverse process of the seventh cervical vertebra with its strong ligaments is now in view. Remove the transverse process and so expose the thin neck of the rib. Pass a curved elevator around the neck of the rib and divide it, being careful not to injure the nerve roots immediately in front of it. Seize the rib with strong forceps and with sharp and blunt dissection free it from its connection as far forwards as possible. If the rib is too long or its anterior connections are too firm to permit complete and easy removal through the posterior wound, finish the removal through an anterior incision. The results obtained from excision of cervical ribs have usually been good. Streissler ("Ergebnisse der Chir. und Orthopedie," v, 280) gives an exhaustive account of cervical ribs.

CHAPTER XXI

EXCISION OF CERVICAL TUMORS

The various operations for the removal of cervical tumors, if at all extensive, should never be undertaken by a tyro in surgery. These operations are very dangerous in the hands of one who is not possessed of a good working knowledge of anatomy, especially of the anatomy of the living, and of wide surgical experience.

A good type of the operations under discussion is the removal of tuberculous glands. Ideally, when the disease is extensive, one should endeavor to remove all the cervical glands, and their lymphatic connections in one piece. This is, of course, impossible; but it is a good plan for the surgeon to try to approximate the ideal, even although he knows that his endeavors to do so will fall far short.

Greenwood Sutcliffe ("Practitioner," lxxxviii, 641) gives the following indications for the treatment of tuberculous cervical glands in children. When the disease has lasted not more than six months dietetic treatment with rest (in the open air) gives good results. Rest here means lying down and not running about. When the disease has lasted longer, there is usually caseation and operation is demanded. The author has found that suction hyperemia is often of great benefit in recent disease and that where caseation has taken place or even where abscess has formed, a small incision followed by suction hyperemia after the Klapp-Bier method, often renders excision unnecessary. When a reasonable trial of these simpler remedies fails, operation is proper.

What are the dangers of the operation?

1. **Hemorrhage.**—If care is taken, bleeding need cause little anxiety. The precautions taken to avoid air embolism will certainly have the effect of preventing much hemorrhage.

2. **Air Embolism.**—During inspiration the blood in the cervical veins is under negative pressure. If under these circumstances the vein is wounded, air is liable to be sucked into it and thus into the heart—a very fatal accident. Careful attendance to the principles of technic for cervical operations will obviate most of the danger.

(*a*) The wound through the skin and fascia should be large enough to give free access to every part to be operated upon.

(*b*) The wound should be kept moist, and if the slightest "hissing" sound be heard in the wound, the finger should press the tissue at a point nearer the heart than where the wounded vein is. The "hissing" signifies entrance of air. The digital pressure is meant to hinder the passage of the air towards the heart. At the same time as the finger pressure is applied, a spongeful of

water must be squeezed into the wound. This effectually prevents more air getting in. The wound in the vessel must be caught by pressure forceps. J. B. Murphy places a small pack of gauze, with a thread attached to it to keep it from being lost, under the sternal attachment of the sternomastoid muscle. The pressure of the pack keeps the cervical veins full, prevents the danger of negative pressure, and makes the veins very visible. This expedient is of great value; the trifling increase in hemorrhage is of no importance. When "hissing" in the wound occurs and makes one suspect air embolism, remember that it may be due to the pleura being accidentally opened. The pleura extends an inch or more above the first rib.

(*c*) No more cutting should be done than is absolutely necessary. Blunt dissection is most meritorious.

(*d*) *Never* cut in the dark or without full knowledge of the safety of what is being divided.

(*e*) Bleeding points are at once caught by pressure forceps. If it is suspected that forcipressure kept up for a few minutes will be insufficient to stop the bleeding, the vessel should be secured by a fine ligature.

(*f*) In removing the glands no forcible tearing should be perpetrated. Veins are often very friable.

(*g*) Structures about to be cut ought *not* to be on tension. Tension empties veins and makes them look like bands of fibrous tissue.

(*h*) When in the *slightest* doubt as to the contents of a strand of tissue which must be severed, apply two forceps or two ligatures and cut between.

When, in spite of all precautions, air has been sucked into a vein, fill the cervical wound loosely with wet gauze; do not apply forceps to the vein; during the succeeding expirations forcibly compress the chest; do *not* lower the head and shoulders of the patient.

3. When operating down low in the neck on the left side, **avoid injuring the thoracic duct.** Such injury is not uncommon. If noticed at the time, one sees a little clear fluid escaping. Compression sutures in the vicinity of the injured duct *plus* gauze packing usually leads to recovery, but fluid escapes, in spite of treatment, for about two weeks, and there is great emaciation. The injury generally heals in about three weeks or less. P. Lecène thoroughly discusses this accident ("Revue de Chir.," Dec., 1904).

4. **Injury to Important Nerves.**—The danger of injuring important nerves in the neck is by no means great. The vagus is well protected, lying in the carotid sheath. If care be taken, the spinal accessory nerve can usually be recognized and often preserved; its preservation is of much greater importance in the young than in the mature. Injury to the phrenic and the recurrent laryngeal nerves is extremely rare. Injury to the cervical sympathetic system seems to produce no ill results.

The Operation.—In slight cases where the glands are neither numerous nor adherent the operation is extremely simple. An incision is made over the swelling, and through this the tumors are easily shelled out. The method of operating about to be described is for extensive and complicated disease.

The patient lies on his back with the shoulders supported and the head turned towards the side. The scalp should be covered by a well-fitted gauze or rubber cap, to keep the hair out of the way. An oblique incision is made along the sternomastoid muscle from the mastoid process to near the sterno-clavicular articulation. The external jugular vein is exposed and divided between two ligatures. The skin anterior and posterior to the incision is dissected from the subjacent tissues and retracted. If necessary, a second cut may be made parallel to and near the clavicle, from the lower end of the oblique incision outwards. Another incision, and one which leaves little noticeable scar, follows the margin of the vertical hair line of the back of the neck; to this cut is joined one following the clavicle forwards (Fig. 325). Expose the sternomastoid and free it from its surroundings throughout its whole length. Notice the point of emergence of the superficial cervical nerves at the posterior edge of the muscle; the nerves are not small, and here the muscle is more firmly attached

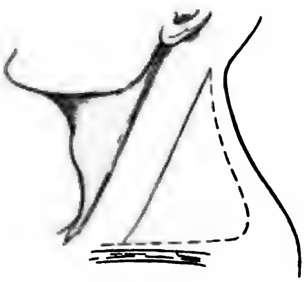


FIG. 325.

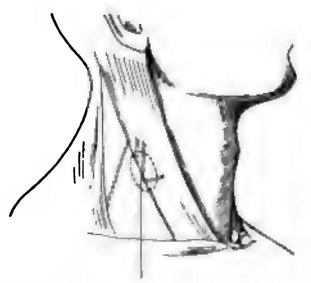


FIG. 326.—Superficial cervical nerves.

to its surroundings than elsewhere, hence this point constitutes an anatomic landmark (Fig. 326). One-half inch above this landmark the spinal accessory nerve emerges from the sternomastoid muscle and is easily found. The nerve enters the muscle about two inches below the tip of the mastoid process, after passing over the prominent transverse process of the atlas. In cases of tuberculosis it is commonly easy to trace the nerve in its course to the trapezius and to separate it from the diseased structures. In the young it is important to preserve the nerve, because Fenger has shown that its division leads to drooping of the shoulder and to scoliosis.

The packet of fascia which contains the carotid artery, internal jugular vein, and the vagus must now be exposed. Once exposed, the protection of these extremely important structures becomes more or less easy. Up to this time no attempt has been made to remove diseased tissues. The disease is now attacked. Beginning near the lower end of the wound and by the side of the carotid packet, the removal of the diseased glands with the gland-bearing fascia is generally a comparatively easy matter and can be carried out systematically. If the important anatomical structures are not exposed and protected at an early stage in the operation, systematic, thorough removal of the disease is very difficult and dangerous. The diseased structures having been

removed and all hemorrhage stopped, carefully suture the wound in the cervical fascia, preferably with catgut. Suture of the fascia and platysma most notably removes tension from the skin-wound. If the fascia is not well united, the skin-wound is liable to stretch and give rise to a wide, ugly scar. Provide drainage at the lower angle of the wound. Close the skin-wound neatly, using intradermic sutures or ordinary sutures, preferably of horse-hair. Horse-hair sutures, being elastic, leave less scar than sutures of any other material. After operations on the neck, very extensive dressings are required as small dressings are difficult to keep in place.

In the course of any operation for the removal of tuberculous glands some of them may be ruptured and from them there escapes caseous material. Such extravasated matter must be carefully wiped away, and it is good practice to scrape the remnants of the caseated material from the ruptured gland, subsequently mopping the part scraped with liquid carbolic acid, followed by the application of alcohol to neutralize the carbolic. When glands are so firmly united to the great vessels of the neck that their removal is very risky, it is proper to remove as much of the gland as possible and sterilize the remainder with liquid carbolic, afterwards neutralizing with alcohol.

Subcutaneous Removal of Tuberculous Glands in the Neck and Submaxillary Regions (Dollinger's Operation).—The operator sits behind the head of the patient and wears an electric headlight. An assistant holds the patient's head free and moves it to suit the convenience of the operator. Beginning near the external auditory meatus, make an incision, 2½ to 3 inches in length, downwards and backwards, parallel to and about ⅛ inch from the margin of the hair. Through this incision packets of glands in almost all the cervical region may be reached and removed by blunt dissection, the surgeon undermining the skin to a point below the packet to be removed and removing the glands from below upwards. Nerves and vessels must be pushed aside. When the glands are seized with forceps, they often tear or collapse, especially if they are caseated. This accident, according to Dollinger, does no harm, provided the débris is promptly washed away. Cases in which peri-adenitis has caused the formation of many firm adhesions are unsuitable for this operation. After removal of the glands the whole wound must be reviewed, cleaned, drained, and sutured. The hemorrhage is remarkably slight.

The location of particular groups or packets of glands is as follows: I. The retroauricular and subauricular glands lie next to the incision and are easily removed.

II. The preauricular glands lie on the partoid beneath the masseteric fascia which they penetrate and so reach the subcutaneous tissues. To reach them pass under the external auditory meatus. The facial nerve is not in danger.

III. The glands under the head of the sternomastoid lie posterior to the accessory nerve, which must be carefully preserved.

Glands also lie in front of and beneath the nerve and must be removed with great care. One reaches these glands from the wound by dissecting under the posterior edge of the sternomastoid.

IV. Glands in the vicinity of the lower end of the parotid gland and of the posterior facial vein are reached by burrowing between the skin and the sternomastoid. When the disease is of long standing, the posterior facial vein is often obliterated. Preserve the external jugular vein and the great auricular nerves.

V. Glands about the submaxillary salivary glands. These are usually three in number and lie between the salivary gland and the lower jaw. One next burrows between the skin and the sternomastoid to the group of glands anterior to the muscle, and illuminating the wound with the headlight, opens their fascial covering and removes them bluntly.

VI. The submental glands, two in number, lie between the anterior bellies of the digastric. These are best removed through a small incision directly over them.

VII. Glands in the lateral triangle of the neck number about 50. The upper ones can be easily reached through the primary incision. The lower ones lying in loose connective tissue are easily pushed upwards and extirpated. Look out for and preserve the branch of the spinal accessory going to the trapezius, the cervical and the brachial plexus. These structures are separated from the glands by a layer of cervical fascia. The external jugular vein is often obliterated.

VIII. The deep cervical glands lie along the great vessels under the sternomastoid, and can be reached by undermining the muscle. If the glands are firmly united to the vessels, pull them to the surface with a sharp hook and carefully dissect them free. Remember that the traction empties the internal jugular vein and makes it look like an innocent band of tissue.

This proceeding seems to the author very hazardous. Dollinger's operation seems to be excessively difficult, and may easily be very incomplete, but that surgeon has performed it in very many cases, and with excellent results. [Dollinger's description of his operation appears in the "Proceedings of the German Surgical Society," 1903.]

When the disease for which operation is required is malignant, almost everything holds good which has been said regarding the excision of tuberculous glands, but the work is more complicated and difficult. That malignant disease should be excised as thoroughly as possible is as true in the neck as elsewhere, but thoroughness is more difficult to attain in this region. The incision made must vary according to circumstances. It may be obliquely vertical, transverse, or a horseshoe-shaped flap with its pedicle upwards or downwards may be dissected from over the tumor. When the growth is exposed, it must be separated from its surroundings. In doing this it is usually wise to attend to the most dangerous part first. Thus, when feasible, the surgeon should begin the enucleation at the point nearest the large vessels, so that in case of accident or difficulty these may be under control. If the carotid artery or the internal jugular vein passes into or becomes inseparably united to the tumor, it is well to know the trouble early in the operation so that one may intelligently make up his mind as to the propriety of braving the

dangers of a completed operation or the advisability of closing the wound before it is too late to recede.

The carotid artery lies deeper than the vein and is rarely involved in the disease. The vein is often infiltrated or surrounded by the tumor and requires ligation or removal, which is not particularly dangerous. Ligation of the common carotid has a mortality of about 26 per cent. (from cerebral softening principally). In operations for malignant disease Crile applies his clamp (Fig. 327) to the artery and thus temporarily controls it. Some surgeons throw a soft temporary ligature around the artery, which serves the same purpose as Crile's clamp but does not do so in quite as elegant a fashion. Temporary control of the carotid is of great value in operations for malignant neoplasms.

If it seems probable that the tumor may be dissected free from the vessels, it is often proper to lay a ligature loosely in position around the internal jugular vein (to the cardiac side of the growth) so that, should air embolism be seriously threatened during the later stages of the operation, an assistant can quickly tighten the thread and avert danger.

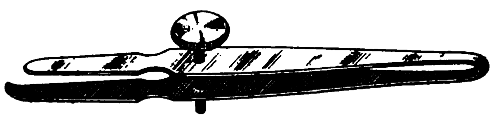


FIG. 327.—Crile's clamp.

Note.—In connection with severe surgical operations on the neck it should be distinctly understood that section of the vagus nerve is not necessarily fatal. Giordano (quoted in "Annals of Surg.," June, 1894) finds that after maltreatment of the nerve in surgical cases the mortality is not higher than 45 per cent., while in resection it is 75 per cent. Crile ("Problems Relative to Surgical Operations," 1901) has made numerous experiments on the vagus and reports a number of cases in which the vagus of one side was excised without ill effect. Before operations in which the vagus may be irritated or divided he finds it wise to administer 1/100 grain of atropin in order to prevent any cardiac or respiratory inhibition.

Hydrocele of the Neck; Cystic Lymphangioma.—A hydrocele of the neck consists of a monolocular or multilocular cyst which may extend into the anterior mediastinum or deep down among the large vessels of the neck. The disease is congenital. Of course, the ideal treatment is extirpation, but this is rarely proper because of its difficulty and danger. If extirpation is decided on, the operation ought to be delayed until the end of the first year of life (Arrou). The most common operative treatment consists in evacuation by trocar and cannula, followed by irrigation with a 2 per cent. solution of carbolic acid, or by injection of tincture of iodine diluted with water. This simple treatment often gives excellent results; it is liable to fail when there are many compartments or loculi in the cyst. When evacuation and injection fail or are inappropriate, marsupialization affords a means of treatment which is thorough

and is safer than extirpation. Marsupialization consists in incising the cyst; suturing the edges of the wound in the cyst to the skin; opening the subsidiary cyst cavities; evacuating all the contents and providing for drainage by means of a gauze tampon. In the course of the operation part of the cyst-wall may be removed and the interior of the cavity may be swabbed first with liquid carbolic acid and then with alcohol to neutralize the carbolic.

Cognenital cervical fistulæ require radical treatment when they give rise to much inflammation or to cystic tumors; esthetic considerations may call for their removal. Occasionally the fistulæ are shallow and their extirpation is then easy. Usually they are complete, reaching from the neighborhood of the tonsil (Rosenmüller's fossa behind the tonsil), passing under the digastric muscles to penetrate the cervical fascia and the skin in almost any location between the sternomastoid muscles. Such fistulæ must be *completely* excised, otherwise recurrence is liable to take place. The skin-incision must be extensive and the cord-like fistulous track followed (preferably without being opened), under guidance of the eye, up to its pharyngeal termination. The dissection is not one for the tyro in surgery to attempt. The removal of the pharyngeal end and closure of the pharyngeal wound are most difficult, but this difficulty has been evaded in a most ingenious manner by Fritz König. After the fistula has been mobilized to a point above the digastric muscle, König separates it still further from its surroundings by blunt dissection until the pharyngeal mucous membrane is nearly reached; then he opens the mouth with a Whitehead speculum, passes a stout probe with an eye on the proximal end through the wound, and makes its point appear elevating the mucous membrane in front of the lower margin of the tonsil. An incision made through the mouth over the end of the probe permits the latter to be pulled through, and with it a thread of silk. The end of the fistula, after being tied to the thread, is easily pulled into the mouth, fastened by a couple of stitches to the wound in the mucosa, and its free end cut away. The external wound is now closed. Instead of a long fistula leading from the pharynx to the skin, there is a short, harmless fistula leading from the back to the front of the tonsil. This simple "dodge" of König's is one of great value.

Median cervical fistulæ are different from those alluded to above; they are the result of non-obliteration of the thyroglossal duct. The thyroglossal duct leads from the foramen cæcum on the tongue through the root of that organ down to a low point in the neck. On its way down the duct either passes through or is closely connected with the body of the hyoid bone. Excision of a patent or inflamed duct below the hyoid is easy; above that bone, it may be difficult or easy, generally the former. If the duct passes through the hyoid, the portion enclosed in the bone must be thoroughly removed even if it is necessary to excise a portion of the bone itself. Occasionally that part of the duct which traverses the tongue gives rise to a tumor consisting of tissue very like that of the thyroid gland. Cysts arising from distention of the duct above the hyoid may give rise to ranula-like tumors. In treatment of ranula it is well to bear this fact in mind. A stubborn and obscure recurrent

phlegmonous inflammation in the submental region may be due to an unsuspected remnant of the thyroglossal duct.

Lingual thyroid may occasionally be easily shelled out of the tongue or extensive operations may be necessary.

W. G. Spencer (Royal Soc. Med. Surg. Sect., 1914, 163) draws attention strongly to the fact that a lingual thyroid not infrequently is the only active thyroid present in the individual and that as a consequence hypothyroidism must result should that tissue be removed. He writes "from the standpoint of a clinical examination, then, it is of primary importance to recognize the presence of the isthmus of the thyroid gland or the reverse. When the isthmus is absent, so that the tracheal rings from the cricoid cartilage downwards can be felt, it should be assumed that the patient's actively secreting thyroid may have been developed in the course of the thyreoglossal tract, and although there may be a fullness on either side of the trachea suggesting the existence of lateral lobes, yet these may be parathyroids destitute of any true thyroid function."

Spencer thinks that when the lingual thyroid has caused so much swelling at the base of the tongue as to impair breathing or has ulcerated and hemorrhage has followed, then the removal of a small wedge and suture, or a limited application of the cautery is the proper treatment. If it is necessary to excise the lingual thyroid, probably Matti's operation will be found suitable (Archiv. f. Klin. Chir., ciii, 248).

Matti's Operation.—Preliminary tracheotomy is advantageous.

Step 1.—Make a curved collar incision through the skin and platysma at the upper margin of the hyoid bone. The length of the incision depends on the size of the tumor but in any event it ought to be long enough to permit preliminary ligation of one or both lingual arteries beside the great horn of the hyoid. Reflect the flap of skin and platysma upwards as far as possible.

Step 2.—Isolate and divide the middle of the body of the hyoid bone. Split the raphe between the mylohyoid, geniohyoid and genioglossus muscles and retract these muscles laterally along with the two segments of the hyoid bone.

Step 3.—Remove the tumor after dividing its firm attachments to the hyoid bone. This may sometimes be accomplished without penetrating the lingual mucosa. The operation may be much facilitated if an assistant presses upon the lingual surface of the tumor with his fingers in the patient's mouth.

Step 4.—If the mouth has been penetrated, the wounded mucosa must be sutured. The wound must be packed or drained, the muscles sutured correctly and the skin closed except where the drain protrudes.

CHAPTER XXII

EXCISION OF THE CERVICAL SYMPATHETIC

Jonnesco describes the total excision of the cervical sympathetic very nearly as follows:

Step 1.—*Cutaneous incision:* Make a cut from behind the mastoid process downwards along the posterior border of the sternomastoid to a point a little below the clavicle. The external jugular vein is divided between two ligatures.

Step 2.—*Separation of the posterior border of the sternomastoid*: To avoid section of the external branch of the spinal accessory nerve and the difficulties often met in freeing the posterior border of the muscle in the upper part of the wound, make an incision along the muscle parallel and close to the posterior margin. Separate the fibres of the muscle and operate through this elongated button-hole.

Step 3.—*Search for and isolation of the sympathetic nerve:* Retract the muscle and with it the packet of cervical vessels and nerves (carotid artery, internal jugular veins, vagus nerve) inwards and upwards. Two blunt hooks or one wide blunt retractor are useful for this purpose. Look for the nerve in the middle of the wound, either on the posterior surface of the sheath of the vascular packet with which the nerve may have been retracted inwards or on the vertebral column, where it lies in a special aponeurotic sheath. The nerve is easily found. It is impossible to confound it with the vagus, the descending branch of the hypoglossal (descendens noni), or the phrenic. To dispel all doubt as to identity follow the nerve upwards and see the superior ganglion (Fig. 328).

Step 4.—*Isolation and resection of the superior ganglion:* Follow the nerve-trunk upwards to the ganglion and isolate the latter from below upwards by blunt dissection with a director. Divide its afferent and efferent fibres with blunt-pointed curved scissors. When the upper end of the ganglion is isolated, divide or tear away the trunk which leads from it towards the skull (Fig. 329).

Step 5.—*Liberation of the inferior thyroid artery:* This artery is surrounded by a dense and often adherent nervous plexus consisting of the sympathetic trunk and its branches. The nerve often is swollen at this point, forming the middle cervical ganglion. Put tension on the nerve-trunk already isolated and follow it downwards. Elevate the nerve and the inferior thyroid artery together and separate them by careful blunt dissection (Fig. 330).

Step 6.—*Isolation and resection of the inferior ganglion:* This is the most difficult step in the operation, as the ganglion lies deeply imbedded in a special lodge at the base of the neck or even in the thorax, behind the clavicle, against the neck and head of the first rib, between the scalenus anticus and longus

colli muscles and just above the pleura. Using the trunk of the nerve as a guide, penetrate to the ganglion, which lies sometimes internal to, and sometimes (though rarely) external to, the vertebral artery. The ganglion is adherent to the artery and enlaces it in a meshwork of its efferent and afferent fibres (Fig. 330). With appropriate retractors retract the scalenus anticus, thyroid axis, and the vertebral artery and vein, downwards and outwards; retract inwards and forwards the sternomastoid muscle and the carotid sheath with its contents. Divide, with a grooved director, the cellular and aponeurotic tissues covering the vessels and the ganglion. Seize the ganglion with forceps and isolate it successively from the vertebral artery externally and from

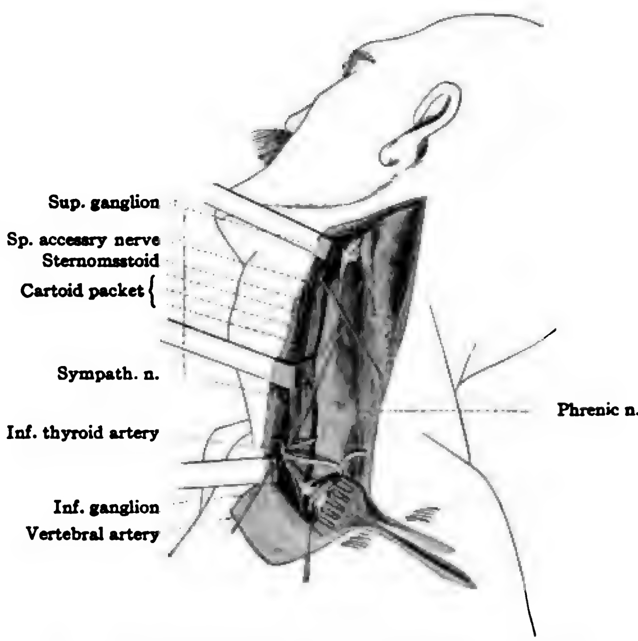


FIG. 328.—Excision of cervical sympathetic. (*Jonnesco.*)

the rib and spine internally. Isolate and divide the afferent and efferent fibres, and remove the ganglion.

The dangers which may be encountered are:

1. Injury to the vertebral artery and vein.
2. Injury to the first intercostal artery or its cervical branch.
3. Injury to the subclavian artery, especially on the left side.
4. Injury to the pleura.
5. Friability of the ganglion, rendering *morcellement* necessary.
6. Intimate union of the inferior cervical and first thoracic ganglia into one mass, from which a portion must be removed.
7. Injury to the retroclavicular venous plexus. This accident will be rare if the trunk of the nerve is followed closely.

7.—*Suture of the Wound.*—Close the wound completely with buried and ial catgut sutures. The superficial stitches ought to be introduced ıtradermic fashion so as to leave little scar. There should be no drainage. lressings.

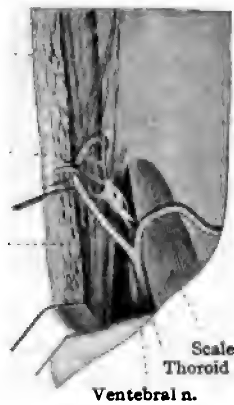


FIG. 329.—(*Jonnesco.*)

mediately after operation on one side the corresponding pupil dilates, :e flushes, eye waters, and nose secretes abundantly. These phenomena, the pupillary dilatation, are very transitory. The pulse falls below l for a few days; after partial resection of the sympathetic it is accelerated. ›eration seems to have no ill effects.

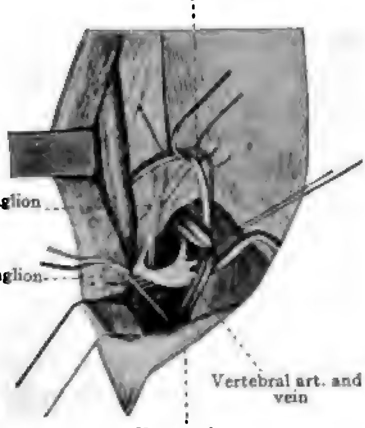


FIG. 330.—(*Jonnesco.*)

r the patient has recovered from the operation on one side the other ould be attacked in the same manner.

nesco ("German Surg. Congress," 1906) has performed cervical sym- omy in 159 cases, in 141 of these the three ganglia were removed with

or without the first thoracic ganglion. In all but two cases the operation was bilateral. There were no deaths and no secondary trophic troubles. The therapeutic results were:

1. Twenty-five cases of exophthalmic goitre (two subtotal resections; twelve complete; eleven cervico-thoracic resections). In every case the disease was primary Basedow's disease, either complete or incomplete, often of serious degree. All the patients recovered, every symptom disappearing. He recommends strongly the complete operation with or without removal of the first thoracic ganglion.

2. *Glaucoma.*—Eighty-eight cases of superior sympathectomy have been collected showing sixty-one cured or improved, twenty-two unimproved, five aggravated.

3. *Epilepsy.*—One hundred and seventeen cases with but twelve definite cures.

4. *Trigeminal Neuralgia.*—In one case resection of the superior ganglion resulted in recovery which has lasted four years, in another case for six months.

De Souza has had similar experiences in Basedow's disease and in facial neuralgia.

Farquhar Curtis finds that the mortality after sympathectomy for Basedow's disease is very high and the ultimate results in the survivors fair. ("Annals Surg.," March, 1906.) Alexander of Liverpool at one time performed sympathectomy frequently for epilepsy but gave it up. The operation is still *sub judice.*

In hyperthyroidism with extreme exophthalmos and nervous symptoms out of proportion to the size of the thyroid C. H. Mayo removes the superior sympathetic ganglion (sometimes the middle one also) and through the same incision ligates the superior thyroid vessels. It is best to operate with both general and local anesthesia. An incision is made opposite the bifurcation of the carotid, the sternomastoid is retracted outwards, the carotid packet is drawn inwards and opened posteriorly so as to demonstrate the vagus as this nerve may be mistaken for the sympathetic. Under normal conditions the sympathetic ganglion is 1/8 to 1/4 inch wide and has many branches. After division of the connecting branches the upper part of the ganglion is torn off or cut and the lower portions of the nerve cut or torn off at the middle ganglion unless that also is removed. The superior thyroid vessels are secured by ligating the upper poles of the thyroid. Sympathectomy causes relaxation of the eyeballs, slight ptosis of the upper lid with general improvement of symptoms. In Mayo's cases when the vessels of both upper poles were ligated in addition to the sympathectomy the primary results were good but time enough has not passed to permit conclusions being drawn regarding permanency.

CHAPTER XXIII

RETROPHARYNGEAL ABSCESS AND TUMORS

There are two methods of opening retropharyngeal abscess, viz., through the mouth and through the neck.

1. **Opening the Abscess through the Mouth.**—No anesthetic, not even cocaine, is permissible. If the pharynx and larynx were anesthetized, there would be increased danger from inspiration of discharges. A knife, the edge of which is protected with cotton or adhesive plaster to within one inch of the point, is guided on the finger of the left hand through the mouth to the posterior wall of the pharynx. An incision is made into the abscess at its most prominent point. The knife is at once withdrawn. If the patient is a child, the operation should be performed in the Rose's position—*i.e.*, with hanging head, and in any case as soon as pus begins to flow the head should be lowered and the body elevated. The after-treatment consists in the use of antiseptic gargles and sprays and in keeping the wound open by daily probing, if this is necessary.

2. **Drainage through the Neck.**—*Chiene's Operation.*—Make an incision two inches in length along the posterior margin of the sternomastoid, beginning at the apex of the mastoid process and running downwards. After division of the deep fascia one can by blunt dissection reach the anterior surface of the bodies of the cervical vertebræ where the abscess is situated. The skin and fascia having been incised as above, the pus may be reached and evacuated by Hilton's method. This is a very safe and easy procedure.

Remarks.—Retropharyngeal abscess may be acute or chronic. It is only for the former that operation through the mouth is suitable. On purely theoretical grounds the operation through the mouth must be condemned for the following reasons: (*a*) When the pus begins to flow there is danger of asphyxiation. (*b*) No dressings can be applied to soak up discharges and keep out dirt. (*c*) There is grave danger of septic pneumonia and of infection to the gastrointestinal canal. (*d*) If the case is one of tuberculous abscess, secondary infection is certain. *Practically* it has been found that by using Rose's position or by inverting the patient during the first flow of pus the danger of asphyxiation is averted, and that in acute cases rapid recovery does ensue. An advantage is claimed for this operation, viz., that an anesthetic is not necessary, but certainly in case of need the external operation can be done under a local anesthetic.

The advantages of the external route are: (*a*) The possibility of careful removal of diseased foci, *e.g.*, diseased bone, etc.; (*b*) the possibility of treating the abscess antiseptically and providing for permanent draining; (*c*) the

possibility of avoiding secondary infection; (*d*) the avoidance of the danger of drowning the patient in his own pus.

The principal disadvantage is the scar which must be left, but as a rule it is not very noticeable.

Retropharyngeal Tumors.—I. The tumor is not adherent to the spinal column, but is movable. Perform tracheotomy. Tampon the larynx or trachea. Place the patient in Rose's position. Introduce a mouth-gag and open the mouth. Pierce the tongue with a needle and pull through a stout thread which serves as a handle to manipulate the tongue. Make an incision through the mucous membrane of the posterior pharyngeal wall and expose the tumor freely. Busch has shown that the tumor lies loosely imbedded in the retropharyngeal tissues and can be shelled out. Generally blunt dissection with closed curved scissors will result in easy removal of the growth. Clean the pharyngeal cavity and the wound with a non-poisonous antiseptic.

If necessary to obtain more room, the soft palate may be divided longitudinally. This wound must be closed by suture as soon as the tumor is removed.

II. The tumor is so extensive that removal through the mouth is impossible. The pharynx must be opened from the neck.

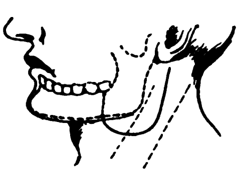


FIG. 331.—Exposure of pharynx from the neck.

Step 1.—Make a U-shaped incision beginning in front of the masseter and ending at the tip of the mastoid process. The lowest part of the U reaches below the level of the hyoid bone. Doubly ligate and divide the external jugular vein. Reflect upwards the skin-flap outlined by the incision (Fig. 331).

Step 2.—Divide the cervical fascia along the anterior margin of the sternomastoid. Expose the external carotid artery. This artery, partly covered by the internal jugular vein, should be sought on the line of the anterior margin of the sternomastoid between a point on a level with the hyoid and one on a level with the upper edge of the thyroid cartilage. Before tying the vessel expose at least one of its branches. This precaution is recommended because the internal has occasionally been mistaken for the external carotid.

Step 3.—Doubly ligate the artery and divide it between the ligatures. Expose as thoroughly as possible such part of the tumor as may present between the inferior maxilla and the mastoid. If it is feasible to remove the tumor through this space, do so; otherwise proceed to the next step.

Step 4.—Cut through the soft structures covering the inferior edge of the horizontal ramus of the lower jaw at a point just in front of the masseter muscle. Through this incision with an elevator separate the periosteum from the bone sufficient to allow of subperiosteal section of the bone. With finger saw, forceps, Gigli's wire or the chain saw divide the bone. Dislocate the temporo-maxillary joint and turn the ascending ramus of the jaw upwards together with the soft parts covering it. This gives very free access to the pharyngeal wall.

Step 5.—Isolate the tumor by blunt dissection if possible. *Do not open*

e pharyngeal cavity before it is absolutely necessary to do so. Remove ie growth.

Step 6.—Pack the cavity with iodoform gauze. Replace the dislocated portion of the lower jaw and wire it in position. Close most of the wound a the soft parts by interrupted silkworm-gut sutures, leaving an opening through which the gauze pack protrudes. Dress.

In one case the writer was surprised to find that he was able to shell out in the above manner a large tumor affecting the right side and roof of the pharynx, without tearing or dividing the pharyngeal mucous membrane.

As a preliminary to the operation tracheotomy may or may not be performed. If the growth, either from size or location, does *not* interfere with respiration; if the surgeon ligates the external carotid artery near its origin and does not open the pharynx until the tumor is almost entirely separated and hemostasis has been secured, then a preliminary tracheotomy appears superfluous.

CHAPTER XXIV

ŒSOPHAGUS

Œsophagotomy.—The œsophagus may be opened either in the neck or in the posterior mediastinum. The latter operation is discussed elsewhere.

Cervical œsophagotomy is performed for the removal of foreign bodies, the treatment of stricture, the excision of small, sharply defined tumors, or as a step in the operation of œsophagostomy. Place the patient on the table with shoulders slightly elevated and the face turned towards the right. Beginning at the level of the thyroid cartilage, make an incision downwards for about three inches along the anterior margin of the left sternomastoid muscle. Divide the platysma, superficial and deep fasciæ. The omohyoid may be divided or retracted according to convenience. Retract the thyroid gland and trachea towards the right. Notice, in the wound, the common sheath containing the carotid, internal jugular, and vagus. Retract these structures to the left. The œsophagus will now be exposed. If a foreign body is present, fix the œsophagus with small volsellum forceps and make a longitudinal cut into it over the foreign body. If necessary, enlarge the wound with a probe-pointed bistoury or with scissors. Gently extract the foreign body. This frequently requires much patience. The incision through the œsophagus should be made on the side, as the recurrent laryngeal lies in the groove between it and the trachea.

When no foreign body is present distending the œsophagus, pass an œsophageal bougie through the mouth and cut down upon it when incising the gullet wall.

v. Hæcker (Muenchener med. Woch., Oct. 15, 1907) reports the case of a pregnant woman who swallowed her plate with artificial teeth. This irregular body became impacted where the œsophagus crosses the left bronchus. Attempts at removal by the œsophagoscope having failed, Friedrich opened the œsophagus just above the upper thoracic aperture and removed the plate after dividing it with cutting forceps. The wound was packed around an œsophageal catheter through which food was administered. Soon an œsophageal-bronchial fistula formed and gangrene developed. Gastrostomy was now performed and for three months the patient was nourished through the gastric fistula. After this time the broncho-œsophageal fistula closed and the patient recovered perfectly.

Bodies impacted low down in the œsophagus have been extracted through a gastrotomy wound in twenty out of twenty-four cases (v. Hæcker). A bougie passed through the mouth gives great assistance in the work.

Foreign bodies may be removed from the lower œsophagus through the

mach. M. H. Richardson successfully performed gastrotomy, explored e lower œsophagus and removed a plate containing four teeth which had en lodged there for eleven months. A peach stone was arrested 6 or 7 ches above the cardiac orifice; the usual measures failed to dislodge it; W. . Bull performed gastrotomy, passed a small bougie, with a loop at its point, rom the stomach to the mouth, pulled a stout thread through the œsophagus with the bougie; tied a sponge to the lower end of the thread and pulled the sponge through the œsophagus and out of the mouth. The sponge swept away the foreign body.

Through the œsophageal wound one may divide or forcibly dilate a stricture or even remove a small tumor. For such purposes, however, the operation will be but little used, as strictures are generally more suitably treated by other means, and tumors eradicable by the above operation must be of great rarity.

Closure of the Wound.—Close the œsophageal wound by a row of sutures of fine catgut not involving the mucosa. Lessen the size of the external wound by a few stitches at its upper and lower extremities. Loosely pack the remainder of the wound with iodoform gauze. Apply plentiful dressings. Treves advises the use of some orthopædic apparatus to secure rest for the parts.

For the first day or two after the operation the patient should be nourished by means of enemata; subsequently food should be administered through a small soft-rubber stomach-tube passed through the mouth. This method of feeding must be kept up until it is evident that the œsophageal wound has healed. The cervical wound requires frequent dressing and the mouth must be washed at short intervals with some antiseptic lotion. The great danger to be apprehended is sepsis, especially septic mediastinitis.

Œsophageal Diverticula.—Diverticula occasionally are present in the neck and communicate with the œsophagus or pharynx. When these are large, food passes into them and serious symptoms, even death, may result. The condition is often unrecognized by the physician. In serious cases operation is demanded. Sometimes good results are obtained by having the patient swallow a whip cord and using this as a guide, passing bougies in a manner analogous to the passage of Gouley's tunnelled sounds over a whalebone filiform in urethral stricture (Mixter).

The Operation.—Proceed as in œsophagotomy. Retract the trachea towards the right, the sternomastoid and the sheath containing the carotid, internal jugular, and vagus to the left. Pass an œsophageal bougie through the mouth into the diverticulum, if this is possible. Recognize the diverticulum and its relations to surrounding structures. Remove the bougie. Separate the diverticulum from its surroundings. This can generally be accomplished by blunt dissection. Where the diverticulum joins the œsophagus its neck may be as thick as a man's thumb. Divide the neck of the diverticulum layer by layer close to the œsophagus. With catgut, suture the wound of the mucous membrane. The wound of the outer tunics of the neck of the diverticulum is closed by an invaginating su[illegible] Lembert's intestinal stitch. Partially close the external wound. I[illegible] free drainage by means of

iodoform gauze. The after-treatment is the same as that for œsophagotomy. When the diverticulum is comparatively small the skin-incision need not be longer than that for œsophagotomy; but when it is large, then the incision must be longer. It is better to make an incision longer than is absolutely necessary than to be cramped, while operating, through lack of room.

Girard and A. E. Halstead in cases of small diverticula avoided opening the sac. After exposing and isolating the sac, they surround it near its base by a catgut purse-string suture, invaginate the diverticulum *into* the œsophagus, pull the purse string tight and tie it. This method avoids the necessity of drainage. The pouch is said to become atrophied.

Gehle's Method.—To avoid dangers of mediastinitis, etc., especially in debilitated individuals, Gehle ("Muenchener med. Woch.") operates as follows:

Expose and isolate the diverticulum. Make a small opening into the distal end of the sac. Remove the mucous membrane as well as possible with a sharp spoon. Through the sac pass a small œsophageal tube into the stomach. Rotate the sac (and tube) on its long axis, to the extent of 180°. Fix the sac in its position of torsion by means of three catgut purse-string sutures after freshening the surfaces to be brought in contact. These sutures tie the sac firmly to the tube. Suture the opening in the sac, where the tube protrudes, to the superficial fascia. Close the wound around the sac. Gehle was able to feed his patient through the tube on the day of operation. The tube was removed on the sixth day. On the sixteenth day both solid and fluid food could be swallowed.

To the author it appears that Gehle is wrong in calling the operation "radical," but in suitable cases it seems to be the least dangerous method and at the same time the alteration in position and shape of the diverticulum promises good practical results. It is difficult to believe that curettement will sufficiently remove the mucosa to permit of obliteration of the lumen.

ŒSOPHAGEAL STRICTURE

Non-malignant strictures of the œsophagus should be treated by the passage of bougies through the mouth. It is said that dilatation may sometimes be aided by the hypodermic administration of suitable doses of thiosinamin (thiosinamin, 15; antipyrin, 7.50; water, 100. Dose, 0.5 c.c. Ten injections usually suffice) or some of its equivalents. This drug acts by softening scar tissue to such an extent that mechanical treatment is greatly facilitated. The œsophagus commonly becomes greatly distended above the site of a stricture hence it is often difficult to pass a sound into the stricture. Under these circumstances retrograde catheterization becomes proper.

Abbe's Operation.—The œsophageal pouch which forms above a stricture is a great hindrance to the passage of bougies. Abbe overcomes this difficulty by retrograde dilatation which he carries out in characteristically ingenious fashion. Perform gastrotomy. Pass a fine whale-bone bougie from below upwards until it protrudes from the mouth. To the end of the

bougie tie two long and stout threads of braided silk (whip cord will do). Pull the bougie out through the stomach wound and leave the two threads protruding from the mouth and the stomach wound. Tie the lower end of one thread to an eye at the point of a conical œsophageal bougie (Billroth). By pulling on the upper end of this thread it is easy to bring the conical tip of the bougie into the stricture and render that stricture tense. Keep up gentle traction to dilate the stricture with the bougie and at the same time pull the second cord upwards and downwards vigorously with a sea-saw motion. The friction of the cord divides the stricture without damaging other strictures. The conical bougie rapidly passes upwards as the friction wears away the strictures, and the largest bougie suitable to the œsophagus is rapidly forced upward to the mouth by a few moments' stretching and "string-sawing." The gastrostomy wound may now be closed by inversion and double suturing. Subsequent passage of a full-size bougie once a week will complete the cure, but must be continued at longer intervals for one year or more. Instead of dividing the stricture by friction and bougies, Ochsner draws a rubber tube, under tension, through the stricture. When the tension is taken off the tubing it expands and so dilates the stricture. In the course of some days, during which larger or double tubes are introduced, Ochsner obtains good results.

The author was much prejudiced against the Abbe operation thinking it harsh and dangerous, but since seeing it performed by Abbe he has changed his views.

In any method of treatment where a gastrostomy is performed, do *not* administer thiosinamine. If this drug has any marked softening effect on the scar tissue forming the stricture it ought to have a similar and disastrous effect on the union between the stomach and the belly wall.

In one case operated on by Maurice Richardson a friable stricture existed in the œsophagus immediately below the opening of a diverticulum. Richardson split or ruptured the stricture longitudinally and repaired the defect by means of a flap provided by the diverticulum. The excess of tissue in the diverticulum was excised.

Œsophagostomy may be performed below a stricture or neoplasm as a means of feeding, but gastrostomy is infinitely easier and safer to perform and is much less disagreeable to the patient subsequently. It may be performed above the stricture to permit the passage of a funnel-shaped tube from the pharynx over the chest wall to a gastric fistula (Glück). The operation is practically the same as œsophagotomy but the œsophageal wound is kept patent either by suturing or by the introduction of a rubber tube.

Cervical Œsophagectomy for malignant neoplasms is not very promising, according to deQuervain's statistics, but if performed early and thoroughly, results ought to be improved.

1. Expose the œsophagus as in œsophagotomy, the incision must be more extensive as a rule. If the thyroid adheres to the neoplasm, remove that portion of the thyroid. Carefully separate the œsophagus from the back of the trachea

and larynx, paying special attention to the preservation of the recurrent laryngeal nerve. Completely isolate the affected segment of the gullet.

2. Choose the line of section at least ½ inch above and below the neoplasm. Introduce an anchor suture of silk or hemp into the wall of the gullet above and below the part to be removed. Divide the œsophagus at the selected points. Attend to hemostasis.

3. A. A very limited portion of gullet has been removed (4 cm., 1½ inches, Czerny), restore the continuity by sutures. B. If a longer portion has been excised and approximation is impossible. Anchor the upper and lower œsophageal stumps to the skin by means of sutures. Pack the wound carefully, paying special attention to protecting the mediastinum. When the wound has become sufficiently covered with granulation tissue a secondary œsophagoplasty may be attempted or a tube may be passed from the pharynx to the stomach as mentioned in œsophagostomy. C. Primary œsophagoplasty (Arbuthnot Lane, "Brit. Med. Journ.," Jan. 7, 1911). Cut a flap of skin about 5 inches long and 2 or more inches wide (according to the amount of disease to be removed) extending horizontally from a vertical line to the left of the larynx over the anterior and right sides of the neck. Reflect the flap up to its base. Expose and excise the affected segment of gullet. Fold the skin flap in the form of a tube of appropriate diameter and suture it carefully to the œsophageal stumps. Pass a tube through the pharynx and œsophagus and leave it *in situ* for feeding purposes. (Gastrostomy is commonly performed as a preliminary operation so that nourishment can be given.) Pack the wound with gauze and partially close it with sutures. D. Secondary œsophagoplasty has been performed by Hæcker and others but it is so similar to the primary operation that a special description is unnecessary.

Antethoracic Œsophagoplasty.—Roux ("Semaine medicale," Jan., 1907) reported an operation for impermeable œsophageal stricture. The operation consists in performing an œsophago-jejuno-gastrostomy.

1. Open the abdomen. Choose a very mobile loop of jejunum. Doubly ligate and divide four or five of the vessels passing to the loop of jejunum preserving the peripheral vascular arcades intact. Be sure that sufficient blood passes through the vascular arcades of the selected portion of gut from unligated vessels near its anal end. Apply intestinal clamps to and divide the gut at both ends of the selected segment.

2. Anastomose the open anal end of the segregated segment to the stomach near its lesser curvature.

3. With forceps make a subcutaneous tunnel from the abdominal wound to the notch of the sternum. Protect with gauze the oral end of the segregated segment of jejunum and pull it up through the tunnel. With sutures fix the upper end of the gut to the upper end of the tunnel. Pass a stomach tube through the segment of gut buried in the chest wall, into the stomach and fix it to the opening at the sternal notch.

4. With suture or Murphy's button restore the continuity of the intestine.

If the patient survives the above rather strenuous procedure the cervical

œsophagus may be exposed, incised and anastomosed to the upper end of the subcutaneous tube by means of flaps of skin.

Th. Glück in cases of malignant œsophageal stricture exposes the cervical œsophagus, makes an opening in it, and unites the opening to the skin. A gastrostomy has also been performed. When the wounds are healed Glück introduces a rubber tube through the mouth to emerge from the œsophageal fistula and pass over the chest to enter the stomach via the gastrostomy opening. The upper end of the tube is funnel shaped so as to remain in the œsophagus. Prof. Glück informed the author that his patients could swallow their food satisfactorily, the bolus passing through the rubber gullet as well as if there was peristalsis.

In one case of œsophageal cancer Kelling ("Zent. für Chir.," No. 36, 1911) found the mesentery of the small intestine too short to permit of Roux's operation being performed so he operated as follows: Laparotomy. The transverse colon was found long and mobile. At each end of the most mobile and convenient segment of colon two intestinal clamps were applied and the gut divided. After restoring the continuity of the remainder of the colon, the right end of the segregated segment was closed with sutures and the left end was anastomosed to the stomach. The meso-colon was divided below the vascular arcade, only the left portion being retained intact. A Stamm-Kader gastrostomy was performed. An incision was made through the skin from the level of the mamma on the left of the sternum down to the abdominal wound and a subcutaneous gutter formed in which the mobilized colon was planted, the skin wound being sutured over the gut. The abdominal wound was closed. After seven days the buried blind end of the colon was opened and its mucosa sutured to the skin. After 25 days cervical œsophagostomy was performed. To unite the upper end of the transplanted colon to the cervical stoma by means of a tube of skin, two parallel incisions about four finger-breadths apart were made through the skin just above the cervical opening to below the fistula on the chest. By undermining it was easy to form a tube of the skin between the incisions and so to complete the new œsophagus. The raw surfaces occasioned by the formation of the epidermal tube were covered by pedunculated flaps of skin taken from elsewhere on the chest.

Instead of using intestine in antethoracic œsophagoplasty, Bircher and Wullstein have constructed a tube entirely composed of skin just as Killing did for part of the œsophagus in his case.

Frangenheim (German Surg. Congr., 1912) reported one case of antethoracic œsophagoplasty in which both skin and jejunum were used; the patient after the lapse of a year was still swallowing all sorts of food without trouble.

Jianu's Œsophagoplasty.—Open the abdomen. Pull the stomach forwards. Divide the great omentum transversely below the gastro-epiploic vessels. Ligate and divide the right gastro-epiploic vessels. The greater curvature of the stomach is now free from the omentum and well nourished by the left gastro-epiploic vessels.

Put a row of mattress sutures through both the anterior and posterior

walls of the stomach along the line A B, Fig. 332. (With a complex machine devised by Hültl, Willy Meyer in one movement inserts a double line of wire stitches along A B and cuts between, thus saving time and soiling.)

Incise the stomach (both walls) along the line CD. Close the flap of stomach between the cut CD and the greater curvature by a double line of sutures (C′D′) so as to form it into a tube open at its distal end (C′) and continuous with the cardia at D.D′. This tube is well nourished by the left gastro-epiploic vessels. Bury the line of mattress sutures by a row of Lembert sutures. The result is seen in Fig. 333. Make a subcutaneous tunnel from the abdominal wound upwards on the chest to about the level of the third

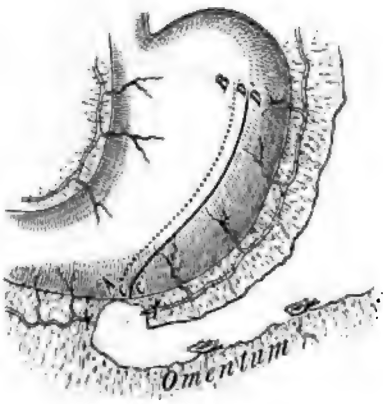


FIG. 332.

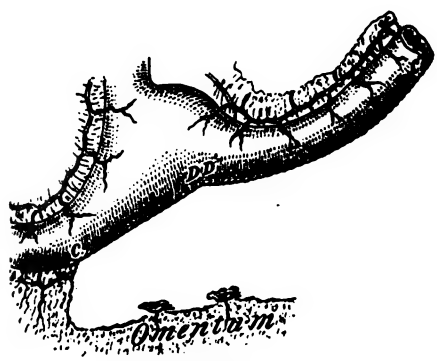


FIG. 333.

costal cartilage. Incise the skin here. Pull the tube of stomach up through this tunnel and suture the mucous membrane at its distal extremity to the skin. The rest of the operation is the same as in some of the procedures already described.

Willy Meyer (Trans. Surg. Section A. M. A., 1913) thinks it feasible to complete the Jianu operation by opening the chest in the seventh left interspace, excising the diseased œsophagus, closing the distal œsophageal stump and making an end to end anastomosis between the proximal stump of the œsophagus and the open end of the "Jianu tube." This would of course be much preferable to the antethoracic œsophagoplasty, is entirely possible technically but must ever remain extremely dangerous.

CHAPTER XXV

PHARYNGOTOMY, LARYNGOTOMY, PARTIAL LARYNGECTOMY, AND LARYNGECTOMY

SUBHYOID PHARYNGOTOMY

Place the patient on his back, the shoulders supported on a cushion and the head extended. Palpate the hyoid bone and thyroid cartilage.

Step 1.—Make a transverse cutaneous incision immediately below and parallel to the hyoid bone. If the operation is for the purpose of exposing the entrance to the larynx, an incision two inches in length is sufficient; if for the removal of a tumor of the pharynx or upper larynx, the incision must be much longer.

Step 2.—Divide the platysma myoides, and omohyoid, sternohyoid, and thyrohyoid muscles close to the hyoid bone, but leaving sufficient of their substances attached to the bone to permit of their union by suture.

Step 3.—Divide the thyrohyoid membrane along the posterior surface of the hyoid, the knife being directed backwards and upwards. Leave enough membrane attached to the bone to permit the use of sutures when closing the wound. Attend to hemostasis.

Step 4.—The mucosa now pouts into the wound during expiration; seize it with forceps and divide it. Be careful not to injure the epiglottis. Insert two catgut sutures into the upper edge of the wound in the mucosa to act as guides or tractors when closure is begun. Pull the epiglottis out of the wound and insert into it a suture to be used as a tractor. The upper part of the larynx and the lower pharynx now lie exposed, and one may proceed to remove any foreign body or accessible tumor. If the operation is done for malignant disease of the upper zone of the larynx (extrinsic disease—Semon), or if any hemorrhage is anticipated, it is well to perform a preliminary tracheotomy.

Step 5.—Close the wound in the mucosa with fine catgut sutures. Unite the thyrohyoid membrane, the divided muscles, and the skin each by a separate layer of sutures. Insert a small drain of gauze or oiled silk down to the line of suture, closing the wound in the mucosa. If a large part of the pharynx has been excised, it is wise to pack the cavity with gauze and only partially close the wound with sutures; under these circumstances a tracheotomy will have been performed.

TRANSHYOID PHARYNGOTOMY

Vallas obtains access to the pharynx by a median incision.

Step 1.—Make a median cutaneous incision from a point one finger-breadth

above the hyoid to the thyroid notch. Divide the skin, subcutaneous tissue, etc., and separate the mylohyoid muscles.

Step 2.—Denude a small portion of the hyoid bone in the middle line and divide the bone with scissors or forceps. Retract the two halves of the hyoid and the attached soft structures. This gives a space about 1½ inches in width, and exposes the mucous membrane of the pharynx above and the thyrohyoid membrane below the bone.

Step 3.—Guided by a finger passed into the pharynx through the mouth open the pharynx, cutting from above downwards.

Step 4.—Having attended to the disease which necessitated operation, close the wound with several layers of suture, after providing for drainage. It is unnecessary to suture the hyoid bone.

SUPRAHYOID PHARYNGOTOMY

Eremitsch, Grünwald, Fedoroff and others recommend suprahyoid pharyngotomy as a means of access to tumors, especially to those at the base of the tongue or on the epiglottis. Preliminary tracheotomy is unnecessary. Place the patient on his back. Support the shoulders letting the head fall backwards.

Step 1.—Make a transverse incision, concave upwards about ¼ inch above the hyoid. Divide the skin and platysma.

Step 2.—Retract the submaxillary gland which present. Find the insertions of the digastric muscles and *preserve* them. Divide transversely the mylohyoids, geniohyoids and hyoglossi. Open the pharynx, being careful not to injure the epiglottis. The pharynx, soft palate, tonsils, epiglottis and the base of the tongue are well exposed. In order to operate on the base of the tongue the posterior half of the tongue must be pulled into the wound by means of a sharp retractor.

INTERCRICOTHYROTOMY. LARYNGOTOMY

This operation is commonly employed as a safe substitute for tracheotomy as a preliminary to operations upon the tongue. Butlin is an enthusiastic advocate of the operation which he uses in all such procedures as excision of the tongue, of the upper jaw, etc. It only consumes about one minute of time and renders easy work which would otherwise be troublesome.

Place the patient on his back with head thrown back and the neck supported on a firm pillow. Identify the thyroid and cricoid cartilages by touch.

Step 1.—With finger and thumb hold the larynx steady. Make an incision 1½ inches long in the middle line over the lower part of the thyroid, the cricothyroid interval, and the cricoid. Retract the edges of the wound. Expose the cricothyroid membrane. Attend to hemostasis.

Step 2.—Divide the cricothyroid membrane transversely just above the cricoid cartilage and so avoid injury to the vocal cords and the cricothyroid vessels. Penetrate the mucous membrane. Pass a closed forceps through the wound in the mucosa and open the blades so as to dilate the wound.

Step 3.—Pass a Butlin's laryngotomy cannula *into* the cavity of the larynx. e error has been made of passing the cannula (Fig. 334) into the cellular ace with nasty results. Fix the cannula in place by tapes passed around neck.

It is easy to administer an anesthetic through the cannula. After the ation on the tongue or mouth is completed the cannula may be removed soon as the patient is put to bed. No stitches are required to close the und.

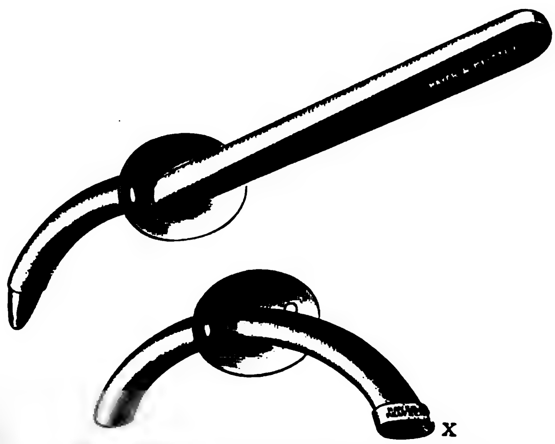


FIG. 334.—Butlin's laryngotomy cannula.
X. Silver tube inserted into cannula. On this it is easy to fix a rubber tube through which the anæsthetic can be administered.

LARYNGOTOMY AND PARTIAL LARYNGECTOMY

Laryngotomy is an operation in which the larynx is split open, its interior xposed, and any foreign body or disease removed. The operation is frequently accompanied by partial laryngectomy.

The Operation.—*Step* 1.—Perform a low tracheotomy. Insert a Trendelenburg or a Hahn cannula.

Step 2.—Make a median incision from a point immediately below the yoid bone to one just below the cricoid cartilage. Divide the cervical fascia o the full extent of the wound. Separate the sternohyoid muscles by blunt dissection.

Step 3.—Incise the cricothyroid membrane after fixing the cricoid cartilage with a sharp hook or small volsellum forceps. With a probe-pointed trong knife, with strong scissors, or with thin-bladed bone forceps divide he thyroid cartilage accurately in the middle line. When the cartilage is ery hard, Treves advises the use of a fine saw instead of the bone forceps. In uch cases probably it might be easier and less damaging to pass a Gigli wire aw through the wound in the cricothyroid membrane, behind the thyroid artilage and out through a cut in the thyrohyoid membrane, and saw through he cartilage in the middle line from within outwards.

Step 4.—Retract the lateral halves of the thyroid cartilage with sharp hooks.

Step 5.—Remove the foreign body or tumor or excise the laryngeal contents completely.

Step 6.—Either completely or partially close the larynx with sutures. Partial closure, a gauze wick being left for twenty-four hours to drain the lower angle of the wound in the larynx, is preferable to complete closure.

Step 7.—Replace the Trendelenburg by an ordinary tracheotomy cannula.

In Step 5 various degrees of interference may be requisite. Even in cases of rather extensive malignant disease below the vocal cords (intrinsic disease) thorough removal of the growth and surrounding soft parts *plus* energetic scraping of the cartilage often gives good results. If the growth invades the cartilage, then portions of that structure must be removed. Sir F. Semon ("Brit. Med. Jour.," Oct. 31, 1903) limits the term partial laryngectomy to cases where *not less* than one wing of the thyroid cartilage, with, possibly, a part of the cricoid and one arytenoid, is removed. Removal of small fragments of these cartilages he includes under the name "thyrotomy."

The lymphatics of the larynx may be considered as being in two groups, one above the other, below the true vocal cords. The cords have very scanty and thin lymphatics which drain into the supraglottic zone for the most part. The network of lymphatics above the vocal cords (supraglottic zone) is very dense, easily injected, covers the epiglottis, the aryteno-epiglottic folds, the superior or false vocal cords, and the ventricles of the larynx. The subglottic zone of lymphatics is not so dense as that above. "Though the two lymphatic territories of the larynx largely communicate with each other in the posterior walls of the larynx, it is rare to obtain a complete injection of the endolaryngeal network by puncturing only one of these territories. It may be added that injections easily cross the middle line; but though the mass injected into one-half of the larynx easily passes into the mucous membrane of the other side, it is, on the other hand, exceptional for it to pass as far as the corresponding glands of that side." ("The Lymphatics," Poirier, Cuneo, Delamere. Leaf's translation.)

The great importance of the above anatomical facts is very evident and they show very clearly the reasonableness of Semon's dicta regarding the conditions required for successful thyrotomy for malignant disease. Semon gives the name "extrinsic malignant disease" to that situated in the supraglottic lymphatic zone, and "intrinsic" to that in the subglottic zone.

Conditions Essential to the Success of Thryotomy for Malignant Disease.—

1. Operation must be restricted to *early* stages of intrinsic malignant disease.
2. Early diagnosis is indispensable.
3. Operation must be thorough. No sentimental considerations as to the amount of vocal power to be retained must interfere with the removal of sufficient healthy tissue from around the neoplasm in all directions.
4. Laryngoscopic examination rarely gives correct information as to the extent of the disease. If, on opening the larynx, the disease is found to invade the cartilages, partial laryngectomy must be performed, "or indeed any other

the necessity of which may become apparent when the extent and filtration of the new growth have been definitely ascertained."

yngeal operations are useless in the face of malignancy: they e away portions of the growth and may stimulate it to more rapid it. Even in cases where there is doubt, but malignancy is strongly thyrotomy is the proper operation. When the disease is situated terior laryngeal wall or when it is too advanced for thyrotomy or yngectomy to be successful, then total laryngectomy becomes a In cases of extrinsic malignant disease of the larynx subhyoid omy gives the best access for its removal.

LARYNGECTOMY

te Laryngectomy.—The operation of laryngectomy is called for malignant disease of the larynx. Usually cases in which the disease through the bounds of the larynx and invaded neighboring tissues ered inoperable, but, as will be seen in succeeding pages, such cases successfully attacked. The greatest danger of laryngectomy is mediate risk of the operation, but the subsequent aspiration of wound into the lungs, causing pneumonia. This danger is combated by psis, or, better, antisepsis, and by using the resources of plastic After operation it is wise to encourage the patient to leave his bed possible.

eration.—*Step* 1.—Perform a low tracheotomy and insert a Tren-cannula to prevent the entrance of blood into the lungs.

—Make an incision in the middle line from the hyoid bone to below cartilage. This divides all the soft parts down to, but not through, ges and their connecting membranes. If necessary, convert the to a T-shaped incision by means of a transverse cut near the hyoid

—(A) Separate the soft parts which are connected with the laryngeal on each side, from the larynx. Do this as much as possible by ection; an occasional cut with knife or scissors will be necessary. this separation keep close to the cartilaginous walls of the larynx. ix is now exposed anteriorly and laterally; it is still united to the above, to the trachea below, and to the œsophagus behind.

the disease has infiltrated surrounding structures, then, of course, of the operation must be carried out by means of dissection beyond e. The operation becomes, in fact, one for the excision of a tumor the larynx happens to be located.

—Stop all bleeding. Divide the thyrohyoid membrane transversely e upper edge of the thyroid cartilage. Injure the œsophagus as sible. Examine the epiglottis carefully. If it is diseased or if its is doubtful, remove it. Carefully separate the posterior wall nx from the [illegible] but always bear in mind the necessity of

getting beyond the disease. The larynx is now attached to the body by the trachea alone. If possible, cut through the cricoid cartilage transversely and remove the larynx. If the cricoid is diseased or in a suspicious condition, make the section through the trachea at as low a point as may be necessary.

Step 5.—Suture the divided trachea to the skin. The trachea is liable to be retracted downwards. Stop all bleeding. Introduce an œsophageal tube into the gullet to permit of feeding. Pack the wound with iodoform gauze. Apply dressings. Replace the Trendelenburg cannula by an ordinary tracheotomy tube.

After-treatment.—Give the patient fluid food through the œsophageal tube, which is left *in situ*. It is probably better to omit the introduction of the œsophageal tube at the time of operation, but to pass the tube each time the patient requires nourishment. The wound should be frequently dressed and the mouth should be kept clean.

In order to avoid confusion the author has described the operation of laryngectomy as if the removal of the diseased larynx constituted the whole of the procedure. It would be almost as logical to amputate the cancerous breast without removing the fatty and lymphatic contents of the axilla as to remove the larynx without attacking the cervical lymphatics at the same time. When the larynx has been removed and provision has been made to retain control of the divided trachea (Step 5), it is easy to gain access to the cervical lymphatics and to remove them in the manner described for excision of cervical tumors or by some slight modification of that method.

Perier's Operation.—In extirpating the larynx Perier discards the aid of a preliminary tracheotomy.

Step 1.—Make a vertical median incision from the hyoid bone down to a point well below the cricoid cartilage. Make two horizontal incisions, one at each end of the vertical cut. The wound is now I-shaped.

Step 2.—Separate the soft parts from the larynx and upper part of the trachea, as has been already described. With a curved blunt instrument introduced laterally separate the larynx and upper portion of the trachea from the œsophagus (Fig. 335).

Step 3.—Stop all bleeding. Introduce a stout thread on each side of the trachea below the line where it is to be divided. These threads are for purposes of traction. Rapidly divide the trachea immediately below the cricoid cartilage and pull the stump upwards and forwards by means of the traction threads (Fig. 336). Introduce into the trachea a large curved cannula provided with lugs through which the traction threads may be passed and fastened. The ends of the threads are left long. The threads prevent the cannula changing its position and can still be used for traction purposes. The anesthesia is continued through the cannula.

Step 4.—Complete the extirpation of the larynx. Close the wound with sutures after providing for drainage.

Step 5.—Suture the tracheal opening to the lowest angle of the wound (Fig. 337).

Th. Gluck brings the tracheal stump out through a special buttonhole in the skin near the sternal notch, thus isolating it from the laryngectomy wound.

Keen's Method.—In 1898 Keen described a method of operating, the details of which lead towards safety. For several days prior to operation brush the

FIG. 335.

FIG. 336.

FIGS. 335 AND 336.—Excision of larynx. (*Monod and Vanverts.*)

teeth thoroughly and spray the nose and fauces with a mild antiseptic every two hours, when the patient is awake.

Step 1.—Give chloroform. Median incision from above the hyoid bone nearly to the sternum. Expose the thyrohyoid membrane, larynx, and two or more tracheal rings. Divide the isthmus of the thyroid.

Step 2.—Separate the structures to be removed from their lateral connections. Attend to hemostasis.

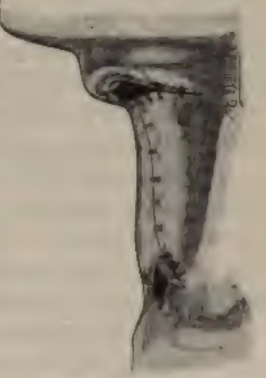


FIG. 337.—Excision of larynx. (*Monod and Vanverts.*)

Step 3.—Put patient in Trendelenburg's position. Divide the trachea transversely well below the disease and below the area of the beard in men (lest hair grow into the trachea). With three sutures fix the upper end of the trachea to the skin. Introduce an ordinary tracheotomy tube ½ inch in diameter. Secure the tube with sterile tapes passed around the neck. Continue the anesthetic through a sterile rubber tube passed into the cannula and provided with a funnel.

Step 4.—Pull the upper end of the trachea forwards, and by blunt or sharp dissection separate it from the œsophagus. Close any accidental wounds of the œsophagus at once with Lembert sutures. Remove the disease and the larynx.

Step 5.—Pull the epiglottis into the wound and remove it.

Step 6.—Suture the anterior wall of the œsophagus to the tissues just below the hyoid bone. This must be done thoroughly to prevent leakage from the mouth into the wound.

Step 7.—Remove the tracheotomy cannula and close the external wound. Provide drainage for twenty-four hours. Apply dressings above and below the tracheal opening, which is protected by any framework—*e.g.*, a pill-box without top or bottom—covered with gauze to filter the air.

After-treatment.—Put to bed without bolster or pillow. Raise the foot of the bed on a chair. Get the patient up as soon as possible (about the third day). For one or two days feed by enemata. By the third day the patient can swallow.

Föderl has paid great attention to means of avoiding postoperative pneumonia due to the aspiration into the lungs of secretions from the open wound generally left after laryngectomy. The method of operating adopted by him is based on experience gained in a case of tracheal stenosis. In this case he resected the affected portion of the trachea and restored continuity by means of a circular suture of the windpipe. The result was perfect. After the trachea has been divided, and provided it is not abnormally adherent to its surroundings, it is very easily pulled up. On the cadaver it has been shown that the larynx may be completely excised, the hyoid bone united by sutures to the first ring of the trachea, the head thrown into a position of overextension, and that the sutures will still hold.

Föderl's Operation.—A preliminary tracheotomy is performed. The larynx is removed, but the epiglottis and the ary-epiglottidean folds are preserved if possible. Hemostasis is carefully secured by means of ligatures, pressure, or torsion. Unite the ends of the ary-epiglottidean folds to the posterior membranous portion of the trachea, and complete the continuity of the posterior part of the tube. The lateral and anterior portions of the windpipe are united by catgut sutures. The sutures are not tied until all of them are in place. Two or more of the anterior sutures surround the hyoid bone (submucously), catch the base of the epiglottis, and surround the first tracheal ring. After these deep sutures are tied, silk sutures are inserted through the soft parts, and help to relieve tension on the buried stitches. The external wound is closed.

Föderl remarks ("Archiv f. klin. Chir.," lviii, 803) that after his operation scarcely any more wound secretion enters the respiratory tract than does so subsequent to any of the endolaryngeal operations. A nearly linear circular wound is left, the windpipe is cut off from the rest of the wound, and there is little danger of the aspiration of wound secretions.

Föderl has operated on one case in the above manner. The patient was out of bed on the second day, able to feed himself with the œsophageal tube on the third day, and went home after two weeks. Eight months after operation there was no recurrence. Deglutition was good. Speech could be heard at thirty feet. The patient still wore a fenestrated tracheotomy tube, but he was expected to give up that before long.

The operation of laryngectomy is not absolutely limited to cases in which the disease is confined to the larynx itself. Portions of the œsophagus, etc., may be removed along with the larynx. Narath ("Archiv f. klin. Chir.," lv,

840) has published some instructive experiences on this subject. The following description is based on Narath's work:

Combined Laryngectomy and Œsophagectomy.—*Step* 1.—Perform a low tracheotomy.

Step 2.—Extend the tracheotomy wound upwards in the middle line to near the chin. Reflect the skin on either side of the neck so as to expose the larynx and surrounding structures. Isolate the diseased organs.

Step 3.—Divide the trachea below the disease. The inferior portion of trachea (*i. e.*, the portion leading to the lungs) is separated from its surroundings for a short distance and its open end brought into the tracheotomy wound in the soft parts; and is there sutured after the tracheotomy tube is removed. In the manœuvre the open end of the trachea is so bent that its opening faces directly forwards. There is little danger of blood being aspirated into the tracheal opening in its new position.

Step 4.—Remove the larynx and such portions of the œsophagus as may be diseased, remembering to cut away too much rather than too little.

Step 5.—If comparatively little of the œsophagus has been removed, it may be possible to secure closure of its lumen by means of suture. If a large portion of the anterior œsophageal wall has been removed and a small portion of the posterior, it has been possible to loosen the remnants of the posterior wall from their surroundings sufficiently to permit of the upper and lower fragments being brought together and so to obtain a continuous posterior œsophageal wall.

Step 6.—Pack the whole wound with iodoform gauze. Change the dressings whenever it is desired to nourish the patient. Nutriment is given through a stomach-tube.

As the wound heals the cutaneous edges become inverted and the granulations covered with epithelium until at last the whole space between the posterior œsophageal wall and the skin is covered by epithelium. Thus a gutter is formed leading from the pharynx to the intact œsophagus below. At the lower end of the gutter the tracheal opening is seen facing forwards. The gutter must now be converted into a tube by a plastic operation very similar to the operation for hypospadias.

On each side of the gutter A, B (Fig. 338) make the skin-flaps a b c d and a′ b′ c′ d′. The *hinge* of the flap a b c d is along the line a b; that of flap a′ b′ c′ d′ is along the line a′ b′. Having separated the above flaps from the subjacent tissues, turn them inwards so that the edge d c of the one flap meets and is sutured to the edge d′ c′ of the other flap. The œsophageal gutter has now been converted into a tube the anterior half of which is lined by epidermis. The external or raw surfaces of the two flaps (a b c d and a′ b′ c′ d′) now call for treatment. Continue the horizontal incision a, d outwards to the point e; the incision b c to f; a′ d′ to e′; b′ c′ to f′. Separate the flap e d c f from the subjacent tissues, the base of the flap being the line e f. Do the same with the flap e′ d′ c′ f′. Slide the two flaps towards each other so that the edge d c meets the edge d′ c′ in the middle line. Suture. The sliding of these flaps

is rendered possible because the skin of the neck is so loosely attached to subjacent structures. After healing has taken place, if it is desired to make use of an artificial larynx, it will be necessary to make an opening into the pharynx at the point A (Fig. 339). A cannula is placed in the trachea. By means of a T-joint on the exposed part of the cannula a tube is led upwards over the

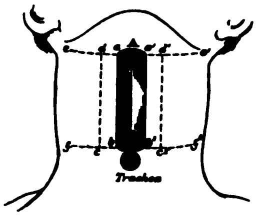


FIG. 338.

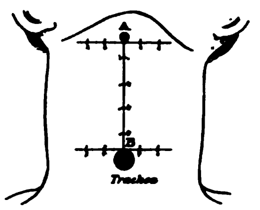


FIG. 339.

FIGS. 338 AND 339.—Œsophagoplasty.

skin through the opening at A into the pharynx. In the cannula is placed a reed. As the patient expires air the reed gives a musical note; the vibrating air is carried into the pharynx through the system of tubing described and is modified by the tongue, lips, etc., into speech. The speech is, of course, in one tone, viz., that of the reed.

CHAPTER XXVI

TRACHEOTOMY

Tracheotomy is an exceedingly simple operation under some circumstances, but when, as is often the case, one has to dispense with the use of an anesthetic and operate on a struggling, choking child, on an inconvenient table, in a badly lighted room, without proper assistance, the task of the surgeon is no light one.

There are two classical sites at which the trachea may be opened—one above, the other below, the isthmus of the thyroid gland. At the former site the trachea is much more superficial than the latter.

The High Operation.—Place the patient on his back with the shoulders raised on a pillow, the head extended, and in a good light. If possible, administer a general or local anesthetic. With the finger locate the thyroid and cricoid cartilages.

Step 1.—From a point a little below the middle of the thyroid cartilage make an incision, exactly in the middle line, downwards for a distance of about 1½ inches. Expose the deep fascia, which is attached to the thyroid cartilage above and the isthmus below. Divide the fascia in the middle line. By blunt dissection expose the trachea, the rings of which are easily felt with the finger. If there is not enough space between the cricoid cartilage and the isthmus of the thyroid (which lies across the third and fourth tracheal rings), make short transverse incisions, through the deep fascia where it is attached to the thyroid cartilage; this permits one to drag the isthmus downwards. In children preservation of the isthmus is of little value. Thomas Bryant stated long ago that its division did no harm, and the author, following his advice, has, when operating on children, paid no attention to preserving the thyroid isthmus, but has divided it whenever it seemed convenient to do so.

Step 2.—The trachea is now bare to the extent of three or four rings. Fasten the trachea with a sharp hook a little to one side of the middle line. Let an assistant hold the hook. Guided by the finger, introduce a knife slowly but steadily into the trachea at the lower end of the exposed area. Be careful not to push the knife in so far as to injure the posterior wall of the trachea. Cut upwards in the middle line until three tracheal rings are divided. Hold the knife in position in the trachea until, guided by the knife, one can insert into the trachea a closed hemostat or blunt-pointed narrow-bladed scissors. Withdraw the knife. Open the blades of the hemostat or scissors so as to distend the tracheal wound, and slip a tracheotomy tube into position. There are many manœuvres or dodges to facilitate the introduction of the cannula; the one described has suited the author. A few surgeons discard the cannula

but suture the edges of the tracheal wound to the corresponding edges of the skin. One suture on each side suffices to keep the tracheal opening patent.

Transverse Tracheotomy.—Otto Franck ("Münch. med. Woch.," 1910, No. 6) recommends the following method:

1. Transverse incision over the cricoid. The wound gapes spontaneously, giving excellent exposure.

2. Division of the *linea mediana albicans* and retraction of the muscles down to the isthmus.

3. Transverse incision into the trachea immediately below the cricoid. When the head is extended the tracheal wound remains wide open.

4. Introduction of tracheotomy tube and suture of the excess of skin wound.

When the cannula is removed the tracheal wound closes of itself.

The Low Operation.—The steps in the operation are very similar to those of the high operation. The incision begins near the cricoid cartilage and runs downwards for two inches. After the cervical fascia is divided blunt dissection will serve to expose the trachea. All veins which appear during the dissection must be drawn aside or divided between ligatures or forceps. The index finger of the left hand should be frequently put into the wound to feel the position of the trachea and to discover if any abnormal artery is in the way. The author well remembers the glee with which the late Sir John Struthers used to exhibit a specimen showing an enormous abnormal artery crossing the territory involved in a low tracheotomy. If the isthmus of the thyroid appears, it should be pulled upwards. The trachea is opened in exactly the same manner as is done in the high operation.

The low operation is not suitable in children, as in them the trachea is very deeply situated, their necks are short, and the thymus gland gets in the way. For adults and adolescents the low operation is suitable.

When the operation is performed in cases of obstruction from external pressure, *e.g.*, in cases of goitre, and some obstruction exists below the tracheotomy opening, a tube should be passed down the trachea beyond the obstruction. In emergency, one may use a gum-elastic catheter for this purpose, passing it through the tracheotomy cannula. Kōnig has devised a special metal cannula with a long pliable tube which is occasionally of service (Fig. 340). When a tracheotomy tube has to be worn for a long time, one made of hard rubber is less irritating and more durable than the usual metal instrument. Fenestrated tubes permit the patient to breathe through the natural passages, and are useful to test whether it is safe to discard the cannula or not.

Trendelenburg's cannula (Figs. 341 and 342) has rubber so arranged round the intratracheal part of the tube that it can be inflated and fill up the space between the trachea and the tube, thus preventing the entrance of blood, etc., into the lungs. This cannula is of great service during certain operations on the upper air passages, as through it anesthetics may be administered.

Instead of surrounding the tube with an inflatable rubber bag, some surgeons prefer to cover the tube with compressed sponge, which when moistened swells *in situ* and serves the same purpose. (Hahn's cannula, Fig. 343.)

When a tracheotomy cannula is in position, it must be retained by means of a tape passed round the neck and secured to the eye-holes provided in the instrument. The inner tube should be frequently removed and cleaned. During the first few days after operation the outer tube should never be removed except by the surgeon. Patient or nurse should never be permitted to remove

FIG. 340.—König's cannula.

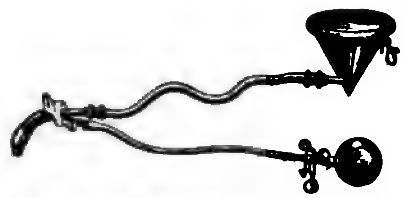


FIG. 341.—Trendelenburg's cannula.

FIGS. 340 AND 341.—(*Esmarch and Kowalzig.*)

the outer tube until the surgeon has satisfied himself by observation that they are capable of replacing it.

Tracheotomy is occasionally performed as a preliminary to such operations as excision of the larynx, Kocher's excision of the tongue, etc. Preliminary tracheotomy is either mediate or immediate. When the "mediate"

FIG. 342.—Trelendenburg's cannula *in-situ*.

FIG. 343.—Hahn's cannula.

FIGS. 342 AND 343.—(*Esmarch and Kowalzig.*)

operation is chosen, it should be performed two or three weeks before the major operation to which it is preliminary.

The advantages claimed for mediate tracheotomy are: (1) The patient has free respiration for a period of weeks and so may gain strength. (2) The patient becomes accustomed [illegible] iring air which has not passed through the nos[illegible] mouth. (3) [illegible] wound becomes fixed to the soft parts, [illegible] the wind[illegible] enting retraction after the larynx, for

example, has been excised. (4) The tracheotomy having been done before hand, the duration of the major operation is shortened thereby.

Advocates of the immediate operation claim: (1) That the time consumed in performing tracheotomy is not sufficient seriously to influence the success of the major operation; (2) that it is unnecessary to accustom the patient beforehand to breathing through a cannula; (3) that while the patient is breathing through the cannula discharges from the cancerous tongue or larynx are liable to gravitate down the trachea, past the cannula into the lungs, and cause pneumonia, while the resisting power of the lungs is lowered from receiving air directly through the tracheotomy tube; (4) that if any attempt is to be made to restore the continuity of the windpipe after laryngectomy, the adhesions formed around the tracheotomy wound will prevent the necessary elevation or pulling up of the lower trachea.

In the opinion of the author the disadvantages of mediate tracheotomy are greater than the advantages, and the immediate operation is preferable, except when it is preliminary to excision of the tongue.

CHAPTER XXVII

FOREIGN BODIES IN TRACHEA OR BRONCHUS

:times foreign bodies may be expelled from the trachea by inverting ent, but, as a rule, the body impinging against the larynx will set up ısm as to render its expulsion impossible. Lejars is most vigorous in .unciation of the method. Tracheoscopy or tracheo-bronchoscopy), whether the tube be introduced through the mouth or through a tomy wound, has frequently permitted the extraction of foreign bodies. a most valuable procedure, but unfortunately requires an elaborate ıtly instrumentarium as well as a technical dexterity possessed by but 3y far the most available treatment is the high tracheotomy. A gen- esthetic is desirable. Do *not* place the patient in the dependent posi- ıtil the trachea is opened. After opening the trachea and retracting ;es of the tracheal wound with retractors or stitches, the foreign body en pop out, or may be lifted out with forceps or a scoop. If the foreign oes not promptly appear opposite the wound, investigate the lower sur- the glottis; if the body happens to be there, remove it. Lowering the .'s head and shoulders, after opening the trachea, is often helpful. Touch- : mucosa of the trachea excites coughing and so may force the foreign nto view. Coughing and inversion of the patient may bring a non- ed body from the bronchus into the wound.

he above measures are successful the author inserts a linen or silk suture trachea on each side of the wound and leaves these long to serve as s by means of which the nurse may easily open the trachea should glottidis or such like accident develop. These threads may be re- after twenty-four or forty-eight hours. Cover the wound loosely with moist, non-fluffy gauze. Instead of the thread tractors a tracheotomy a may be used. It is *not* a safe practice to close the wound entirely.

the above means fail to give relief it is best either to suture the edges of cheal wound to the skin or to insert a large cannula and let the patient After some hours, or next day, reopen the wound; if the body is not oughed out, introduce a small laryngeal mirror and by the aid of a strong investigate the trachea. If the body is seen caught in the mucosa, spray cocaine and endeavor to extract it with laryngeal forceps or a wire loop. may require several sittings before success is attained.

When a foreign body is impacted in a bronchus and the above measures to give relief, one may either attempt its extraction by means of posterior chotomy or await the formation of a pulmonary abscess which may be ed and drained. Unfortunately, posterior bronchotomy is a formidable

operation and if the Fabian policy is adopted the patient may die before or after soldification of the lung, and pneumotomy under the most favorable circumstances is no triviality.

The bronchoscope has made a great difference in the treatment of foreign bodies in the tracheo and ought to be employed but only by an expert.

POSTERIOR BRONCHOTOMY (SCHWARTZ'S OPERATION)

Anatomy.—The bronchi may be reached through the posterior mediastinum, and as this region is full of vitally important structures it is necessary to review its anatomy in a practical manner. If one excises the third to the

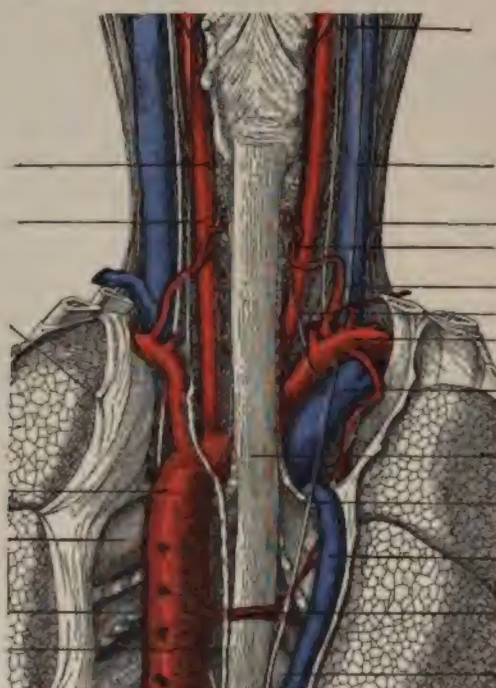


FIG. 344.—(*Poirier and Charpy.*)

ninth dorsal vertebræ inclusive, the posterior mediastinum will be sufficiently exposed for study. The most superficial (posterior) structures which present are vascular, viz., to the left the aorta, to the right the azygos vein. At the lower part of the exposed area these vessels lie alongside each other and hide all subjacent structures. As these vessels ascend they separate, the aorta going to the left where at the level of the fourth dorsal vertebra it passes forwards (as the aortic arch) into the anterior mediastinum; the azygos vein ascends towards the right until it bends forwards at the level of the fourth dorsal vertebra to enter the anterior mediastinum. The aorta and azygos thus form a

.e with base above, and the floor of which is formed by the œsophagus. pex (lower end) of the triangle in about two inches below the bifurcation trachea. The thoracic duct follows the inner side of the aorta and later bclavian artery. The right and left pleuræ approach each other between rta and azygos behind, and the œsophagus in front. The right pleura behind the œsophagus in front of the azygos so as to form a sort of -sac (Quénu). The two pleuræ are loosely connected by areolar tissue. osition of the pneumogastric nerves is well seen in Fig. 344. To expose sophagus it is necessary to retract the pleuræ and with them the pneu-stric nerves. Retraction of the pleuræ and of the œsophagus exposes achea and primary bronchi.

I. RIGHT BRONCHOTOMY

:e *Operation.*—Place the patient in the latero-ventral position on the of the table with the right arm hanging over the table (Fig. 345).

ep 1.—From a point (A) at the junction of the spine and median border e scapula make an incision to a point (B) about 1½ inches to the right

FIG. 345.

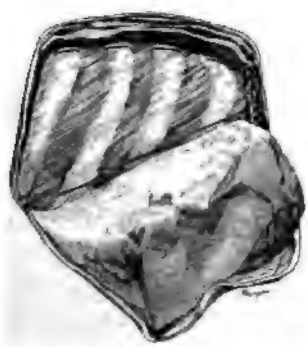


FIG. 346.

FIGS. 345 AND 346.—Bronchotomy. (*Schwartz.*)

the spines of the vertebræ. From the point B, cut downwards parallel to e spinous processes for a distance of about five inches (C). Make the in-sion C, D which passes just below the angle of the scapula. The result the flap A, B, C, D. Reflect the flap A, B, C, D outwards so as to expose e fifth, sixth, seventh and eighth ribs; the flap consists of all the soft parts rs to the ribs. *J. D.* Bryant makes the flap with its pedicle towards the e.

ep 2.—Subperiosteally divide the spinal ends of the exposed ribs just ral to the transverse process (about 1½ inches from the mid-line of ck). In the same way divide the ribs as far outwards as possible. Care-the lower and inner angle of the flap, consisting of ribs and inter-scles, and separate it from the subjacent structures. Divide the al muscles along the posterior or [illegible]e on which the ribs were

divided, carefully exposing and tying the intercostal vessels. Divide the intercostal muscles parallel to and below the lowest rib to be mobilized. Divide the intercostal muscles parallel to and above the highest rib to be mobilized. Carefully separate the parietal pleura from flap of ribs and intercostal muscles; in doing this, gauze dissection, *i.e.*, brushing away the pleura with gauze, will be useful. Turn the flap outwards; this is possible because the ribs have been divided far out and the periosteum and intercostal structures act as a hinge (Fig. 346).

Step 3.—Carefully separate the pleura from the remnants of the ribs attached to the spine and from the side of the vertebræ. Push the pleura and the lung outwards, away from the mediastinum (Fig. 347). As soon as the side of the vertebra is passed, the azygos vein may be seen running vertically through the wound and at the upper end, arching forwards to reach the anterior mediastinum (Fig. 348). Continue the separation of the pleura under the arch of the azygos until the œsophagus, lying on the bodies of the vertebræ, is reached.

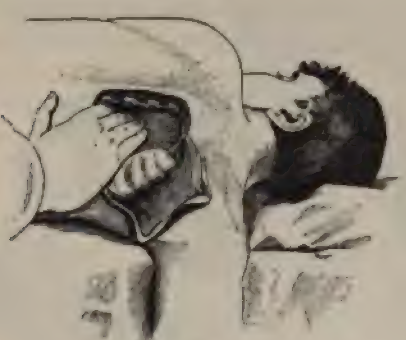


Fig. 347.

Fig. 348.

Figs. 347 and 348.—Bronchotomy. (*Schwartz.*)

External to the œsophagus lies the pneumogastric nerve. Retract the pleura outwards.

Step 4.—Introduce the finger deeply into the wound directly in the concavity of the arch of the azygos and feel the hard, prominent, posterior border of the cartilaginous rings of the bronchus. Pick up the membranous posterior wall of the bronchus with sharp hooks or forceps, and incise it. Remove the foreign body. The exposed bronchus is situated about 2¾ inches from the surface of the ribs (Glück).

Step 5.—Introduce a soft dressed drain to the wounded bronchus, possibly fixing it to the bronchial wound by means of a fine stitch of catgut. Be sure there is no loose "fluff" about the gauze at the end of the tube. The drain must be soft to prevent dangerous pressure necrosis. Replace the flap and sutures leaving or making space for the exit for the drain. If the foreign body has given rise to a peribronchial phlegmon, a more liberal drainage by means of loose packing of gauze may be advisable.

II. LEFT BRONCHOTOMY

Place the patient in the left latero-ventral position with the left arm hanging ver the edge of the table.

Steps 1 *and* 2.—Same as in right bronchotomy except that the work is done n the left side.

Step 3.—Separate the parietal pleura from the remnants of ribs attached to he spine. When the side of the vertebræ is reached, the huge aorta is found ying against the side of the spine. At the upper end of the wound the aorta asses towards (arch of aorta) the anterior mediastinum. Continue the eparation of the pleura under the arch of the aorta to a height of about 2 nches. The left pneumogastric soon presents. Stop the dissection and ull the lung (covered by the intact pleura) outwards with a good retractor. Vith the finger in the depth of the wound feel the posterior prominent edges f the bronchial cartilages. The rest of the operation is the same as in right ronchotomy.

In cases of tracheal stenosis threatening life and comfort, whether the tenosis is from contraction or compression, the ideal treatment is to remove the ause. [Thyroidectomy, tracheal plastic, etc.]. Where this is impossible ne may perform tracheotomy and introduce through the affected area a long annula (König's cannula; lobster tail cannula) but the cannula irritates the ir passages and gives rise to so much trouble that the cannula may require o be removed. Under these grave circumstances, the patient being "between he devil and the deep sea," Th. Glück suggests posterior bronchotomy. In ne of Glück's cases of pneumectomy the patient, while convalescent from the peration and original disease, was able to breathe easily and comfortably hrough the thoracic wound while the nose and mouth were completely closed. This suggestion seems entirely reasonable and should be borne in mind. Posterior bronchotomy is, of course, no operation for the tyro, but in few cases he experienced surgeon may find it of value.

CHAPTER XXVIII

GOITRE; BRONCHOCELE; STRUMA

It may not be out of place to remind the reader that there are several varieties of goitre; viz., parenchymatous, where there is uniform enlargement of the thyroid tissues; adenomatous, where the glandular tissue is in excess and forms single or multiple tumors; cystic, where from degeneration a cavity is formed filled with colloid or other fluid and often containing adenomatous masses. There is also that form known as "exophthalmic goitre," where the tumor is associated with notable general symptoms. In any of the above varieties operation may be required.

THYROID

Experiments and clinical observations have so enriched our knowledge, still woefully scant, of the function of the thyroid and the parathyroid glands

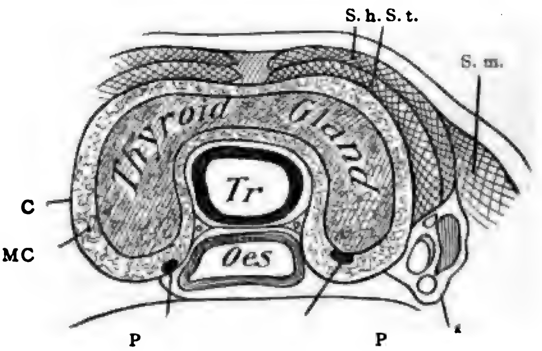


FIG. 349.

C. Fibrous or surgical capsule. P. Parathyroids. MC. Connective tissue packing, or Mayo's capsule. X. Carotid packet of vessels and nerves. Tr. Trachea. Oes. Œsophagus. S.h. Sterno-hyoid. S. t. Sterno-thyroid. S. m. Sterno-mastoid.

that it is imperative to preface any description of the operations performed for goiter by a very few practical remarks on the thyroid and parathyroids, on hyperthyroidism, hypothyroidism and hypoparathyroidism. The thyroid is surrounded by a thin, firm membrane of fibro-elastic tissue which sends processes between the glandular units for their support and which act as pathways for the blood-vessels and lymphatics of the gland. This covering must *not* be considered as a capsule in a surgical sense; it is, surgically, part and parcel of the gland itself. Bands of dense connective tissue unite the covering of the thyroid with the trachea (ligaments of the thyroid). Fig. 349

w the pretracheal portion of the deep cervical fascia forms a fibrous al capsule to the thyroid; it is the structure referred to as the fibrous vhen the operation of thyroidectomy is described. Any space which t between the fibrous capsule and the thyroid gland is filled with nective tissue. The loose connective tissue is apt to be most abundant ne lateral lobes of the gland. This connective tissue under the pres- goitrous enlargement becomes condensed and is what Mayo speaks subcapsular operation.

arathyroids are two or more glandular bodies which exist on each side of behind the lateral lobes of the thyroid. The bodies are elliptical, r 7 mm. long, 3 or 4 mm. broad and $1\frac{1}{2}$ or 2 mm. thick. The length as much as 15 mm." (Piersoll.)

parathyroids lie between the fibrous capsule and the thyroid, in the olar tissue there present; they may be in contact with the thyroid or capsule or with both. Halsted writes, "One is likely, therefore, to er these little bodies, usually two on each side, at any level from the to the inferior pole on the postero-internal surface of the gland, but mmonly just internal to the rounded postero-external border and quite y near the site of the distribution of the terminal branches of the inferior artery. If the thyroid is lobulated in this situation, as is quite com- the case, a parathyroid may be concealed in the cleft between the " The parathyroids "are little ovoid, spheroid, lenticular or very flat exhibiting much variety in form and size and even in color. Externally en resemble fat very closely in consistence as well as in color" (Halsted). od-supply of the parathyroids has been carefully studied by Evans d and Evans, "Annals of Surg.," xlvi, No. 4). The glands are always d by definite parathyroid arteries which usually arise from the inferior , but frequently come from an anastomosing channel existing between rior and superior thyroid arteries.

r, if any, direct vascular connections exist between the parathyroids and nective-tissue envelope of the thyroid.

plete excision of the thyroid glands has been followed by myxœdema tetany. These operations were performed before the importance of athyroids was known. Later, when the thyroid has been completely d, experimentally, but the parathyroids preserved, myxœdema has ed, but not tetany. Hypothyroidism due to degeneration of the thyroid s cretinism or to myxœdema. Overactivity of the thyroid (hyper- sm) gives rise to a complexity of symptoms described by Graves in 1835 Basedow in 1840, and known by the names exophthalmic goitre, Graves' Basedow's disease. Usually the thyroid is evidently enlarged in hyper- m, but sometimes it is apparently normal in size. The normal ap- is, however, only apparent; closer examination shows that the secret- lium, instead of merely lining the acini, pushes in folds into the greatly increasing the secreting surfaces without notably increasing of the gland. This is important to remember. Wh[illegible] thyroid

glands are excised tetany results (hypoparathyroidism). Halsted observed the early symptoms of tetany in one patient and was able to keep the disease in check by the administration of the parathyroids of beeves and later by Beebe's parathyroid-nucleoproteid. In the published statistics of partial strumectomy the death rate from tetany is 3.5% (in Kocher's clinic only ½% (Arnd). Of course there are many cases of non-fatal tetany following partial strumectomy.

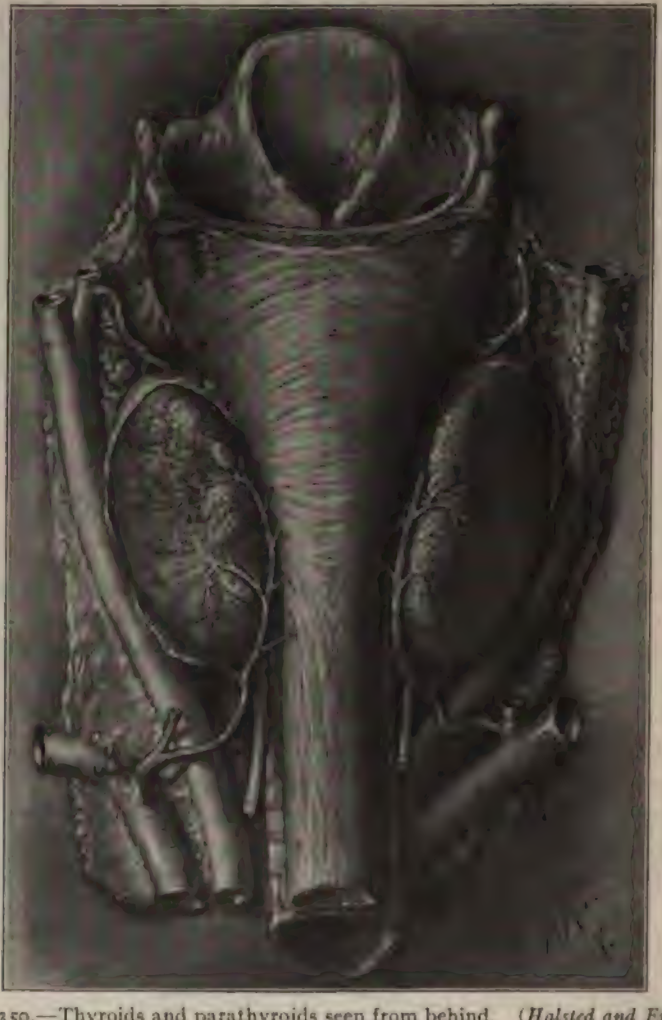


FIG. 350.—Thyroids and parathyroids seen from behind. (*Halsted and Evans.*)

The reason why many cases of tetany recover is probably due to the fact that the parathyroids have not been removed, but that their circulation has been interfered with and has, in time, become reëstablished. One must remember that a lingual thyroid may constitute the whole active thyroid; that its removal may lead to disaster (see p. 218).

Indications for Strumectomy.—Very many goitres are removed for cosmetic reasons. The position, size, and character of the goitre may each constitute a positive indication for operation. Position and size may give rise to respiratory and circulatory troubles, as well as to interference with nerves. The character of the disease indicates whether or not internal treatment may be of value. Soft colloid nodules usually decrease and occasionally disappear during internal treatment. Diffuse strumata are those most suitable to medication with iodine administered externally and internally. Medical treatment must be stopped as soon as it is shown to be ineffective, or the slightest evidence of iodism or of Basedow's disease appears (de Quervain).

The local use of iodine is liable to cause adhesions around the goitre and thus render operation more difficult. Injections of iodine or such like drugs are always improper.

Almost all forms of goitre are suitable for operation if causing symptoms or deformity or increasing in size rapidly. In exophthalmic goitre (Basedow's, Graves' disease) the use of iodine is more dangerous than in other forms. Remember that Graves' disease often remains stationary or improves under any or no treatment, hence operation is by no means always called for, but remember also that, as the disease progresses, the powers of resistance decrease, hence operation must not be too long delayed.

The chief local characteristic of exophthalmic goitre is the great vascularity of the gland. The principle of treatment is to remove degenerated segments and decrease the blood-supply. Kocher, since 1890, has done this by multiple ligation of the thyroid arteries and partial excision. This work he accomplishes in several sittings. Most surgeons operate in these cases exactly as in ordinary goitre.

Kümmel operates either by enucleation or resection of a portion of the goitre or partial ligation of the afferent vessels. His statistics show 70 per cent. recoveries with 5 per cent. mortality.

Kocher ("Brit. Med. Journ.," June, 2 1906), out of one hundred and forty-nine cases, had nine deaths; one hundred and forty cases were kept under observation long enough after operation to permit of a definite statement as to results; of these one hundred and thirty-one were cured and nine notably ameliorated. He writes:

"If we ligature one artery we get some, but only a slight amelioration of the symptoms. If we ligature two arteries the effect will be exactly so much greater as more of the function is inhibited. If we take away one lobe of the gland the effect is still greater. If we put a ligature on three of the four arteries, we may have a very good result, and still better if we excise one lobe and put a ligature on the superior thyroid artery of the other side; it will be even more complete when we combine unilateral excision with the resection of the upper and lower half of the other lateral lobe. If we have begun with one or two ligations, and have had an unsatisfactory result, we are sure to complete it by adding a third ligature or by excision of one-half of the gland. In short, we may say that by operation it is in our hands to guarantee a more or less complete result."

These are Kocher's words, and the surgeon of Berne is *not* given to exaggeration.

In July, 1910, Kocher reported that he had operated four hundred and sixty-nine times for Basedow's disease with a mortality of 3.4 per cent. In the last seventy-two cases there was no death. Glycosuria and hypertrophy of the thymus positively contraindicate operation. To refuse operation during the initial period of the disease is to lose the best chance of success.

Mayo's statistics in cases of exophthalmic goitre are as follows: Prior to January 1, 1906, there were fifty primary thyroidectomies with five deaths (10 per cent. operative mortality).

From January 1, 1906 to July 1, 1910 there were 459 primary thyroidectomies with sixteen deaths (3.4 per cent. operative mortality).

During this latter period there were 267 primary ligations with eleven deaths (4.1 per cent. operative mortality).

The reason for the death rate being higher after ligation than after thyroidectomy is of course that the lesser operation was chosen in the more dangerous cases, in fact in patients for whom any severe operation was entirely unjustifiable.

C. H. Mayo suggests that some of the good results following ligation of the thyroid arteries or after sympathectomy may be due to destruction of many of the lymphatics coming from the thyroid; this destruction of lymphatics is well calculated to diminish absorption of the thyroidal secretions and thus to prevent hyperthyroidism.

The fact that alarming symptoms of hyperthyroidism very commonly follow operations for Graves' disease have led to many endeavors to obviate these symptoms and dangers. None of the endeavors have been proven effectual though some of them may be so. A good rule to adopt is one based on common sense, viz., handle the goitre gently so as to avoid expressing thyroid juices which may be absorbed and cause trouble. Observance of this rule may do good and cannot do harm. It probably does no good as Crile has gently massaged goitres in Graves' disease and has seen no evil follow. C. H. Mayo after removal of goitres swabbed the wound with Harrington's solution so as to close the lymphatics and prevent absorption. He has come to the conclusion, and other surgeons agree with him that this procedure while it may be harmless, is of no particular value. Crile came to the conclusion that fear or psychic shock was a great factor of danger in the highly strung subjects of exophthalmic goitre, and to avoid this he adopted the plan of "stealing" the goitres according to his well-known principles of anoci-association. The patient was kept quietly in the hospital and was daily given inhalations of aromatics by means of the anesthetizing apparatus. Sometimes a little ether was used. Then one day nitrous oxide gas and then ether was administered and only when anesthesia was complete was the patient removed to the operating-room and the goitre removed. This avoidance of fright seemed to give an improvement in results. It is well known that any trauma, even a hypodermic injection of sterile water in the leg, may cause serious symptoms of intoxication in Graves' disease. Crile thinks the trauma causes a nerve impulse to be sent to the gland, thus occasioning an

ejaculation of thyroid juice and that Kocher's success in the use of local anesthesia depends on the fact that the cocaine prevents the nerve impulse reaching the gland. Believing the above, Crile gave a general anesthetic, as described above, to avoid psychic shock and then injected novocaine to produce local anesthesia and thus shut off afferent nerve impulses to the gland. Before closing the wound he blocks the tissues all around by injections of a ½ per cent. solution of quinine and urea, the anesthetic affects of which persist and prevent pain during treating. He thinks that much of the value of ligation of the arteries in the treatment of Graves' disease is due to the coincident impairment of nerve conductivity, the nerves being injured by the ligatures. To the author it seems that the above notions may be valuable but that they contain some fallacies. Klose and others think that failure to cure exophthalmic goitre by operations on the thyroid as well as the severe symptoms following thyroidectomy are due to toxic material coming from the thymus (see p. 274). Riedel performs thyroidectomy under local anesthesia using an extremely weak solution of cocaine or eucaine plus some adrenalin. The injections are massive—first under the skin and then under the deep fascia and fibrous capsule of the gland. A pint or more of the solution is used. This of course obscures to some extent anatomic relationships *but* it so distends the spaces in the areolar tissue between the fibrous capsule and the true capsule of the gland that it practically separates the gland from its surroundings so that it is easy to find and ligate the vessels and remove the gland. If Crile's ideas are correct regarding reflex nerve impulses causing ejaculation of thyroid juice, then Riedel's massive injections are well calculated to cut off these impulses and at the same time facilitate the operation. Mayo's rules for operation in Graves' disease are: If the condition is fair, operate; if the pulse is 130 to 160, or if it suddenly fluctuates in tension and rapidity, if there is anæmia with swelling of the feet, the patients are placed upon belladonna treatment for some days. The more severe types are also given X-ray exposures in addition, a treatment which is continued from two to six weeks.

Whenever the symptoms are severe Mayo contents himself with ligating the superior pole of the thyroid on one or both sides; later, if necessary he removes part of the gland when the patient is in better condition. In very grave cases he treats the goitre by injections of boiling water after the manner of Porter.

Besides the two lateral lobes and isthmus which compose the thyroid gland, the remnant of the thyroglossal duct running up from the isthmus often forms an extra lobe, the pyramidal lobe, and along its course there may be developed irregular masses of glandular tissue—accessory thyroids. The frequent presence of these extra masses of thyroid is not surprising, the thyroid itself being developed from the thyroglossal duct; surgically they are of importance, as their presence is claculated to confuse the operator, ignorant of their existence.

The thyroid is surrounded by a strong covering of fascia—fibrous capsule. When a goitre is present in the gland (adenoma or cyst), it is, of course, surrounded by more or less altered glandular tissue—glandular capsule. The word capsule, being applied both to the outer fibrous covering and to the glandular tissue inside which the tumor lies, leads to confusion when methods of operating

are described. In the succeeding pages the outer or surgical capsule will be called the fibrous; the inner, the glandular capsule.

The arteries of the thyroid are: (*a*) The superior thyroid, entering the upper pole of the lateral lobe; (*b*) the inferior thyroid, entering the posterior surface of the lower pole and in close and, surgically, dangerous relation to the recurrent laryngeal nerve (Fig. 351); (*c*) the thyroidea ima, entering the isthmus from below.

The veins of the thyroid are of very great importance; a study of Kocher's schemata (Figs. 352 and 353) will give a fair idea of their location and importance.

Operations for the cure of goitre may be divided into three groups: I. Excision; II. Intraglandular enucleation; III, Incision and evacuation.

FIG. 351.—Posterior view of trachea, etc., showing course of recurrent laryngeal nerve. (*Esmarch and Kowalzig.*)

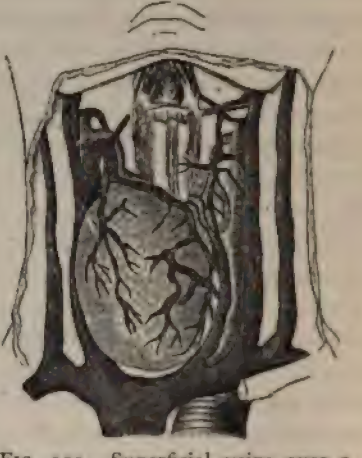


FIG. 352.—Superficial veins over a goitre. (*Esmarch and Kowalzig.*)

I. EXCISION

Complete excision of the thyroid gland is an unjustifiable operation, as it is followed by fatal consequences. As in the case of other organs, nature has been lavish in her provision of functional material in the thyroid, and it is safe to say that one-fourth of the gland is sufficient for the maintenance of health.

TREATMENT AFTER STRUMECTOMY

When drainage has been provided, sufficient dressings must be applied to soak up any discharges. Strips of adhesive plaster are useful in keeping the dressing from being displaced; without adhesive plaster judiciously applied it is extremely difficult to prevent the dressings from becoming so rolled together that there is danger of exposure of the wound. As early as possible have the patient sit up; when the horizontal posture is requisite, encourage him to lie on his back and on each side alternately so as to avoid pulmonary congestion. Es-

pecially after operation for exophthalmic goitre it is of great importance to supply the patient with plenty of liquids. If it is impossible to administer sufficient water by the mouth give it by rectal instillation; *i.e.*, arrange an apparatus so that salt solution trickles continuously into the rectum. If the rectum refuse to retain the liquid, resort to hypodermocylsis. The drain may generally be removed in twenty-four to forty-eight hours after operation. If there is excessive restlessness morphine in efficient doses is the only drug which seems to be effective. Profuse perspiration calls for the administration of atrophine in doses of $\frac{1}{150}$–$\frac{1}{100}$ gr.

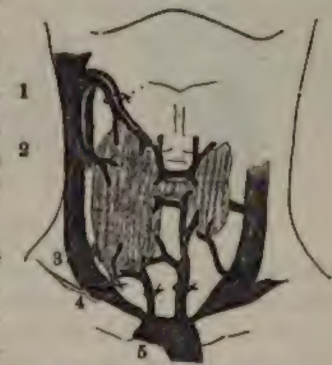


Fig. 353.—(*Esmarch and Kowalzig.*)

1. Superior thyroid artery and vein. 2. Superior thyroid vein. 3. Accessory inferior thyroid vein. 4. Inferior thyroid vein. 5. Thyroidea ima veins (chief and accessory.)

Crile and others have found anatomic changes in the brain resulting from thyroid intoxication. Such patients appear to have an increased susceptibility to thyroid juice. Having by operation cut off excessive supplies of thyroid juice, it becomes necessary to treat the patient still further and endeavor to repair any damage which the nervous system may have sustained. For this purpose nothing is better than some form of rest cure lasting several months.

DeQuervain's methods of operating upon the thyroid are worthy of serious study.

1. *Ligation of the Inferior Thyroid Artery External to the Fibrous Capsule of the Gland.*—Through Kocher's collar incision divide the platysma and expose the

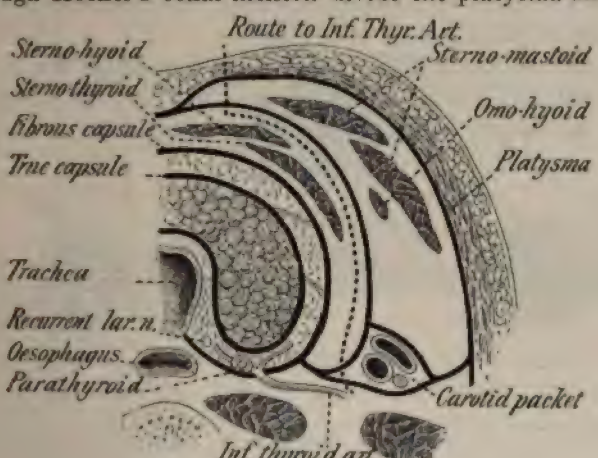


Fig. 354.

inner margin of the sternomastoid muscle. Retract the muscle gently outwards (Fig. 354). Make a vertical incision about 1 inch in length through the external fascia of the sternohyoid; separate this fascia from the muscle and

retract it outwards with the sternomastoid. It is now easy to penetrate the loose connective tissue until the carotid packet of vessels and nerve is reached. Note the carotid tubercle of the transverse process of the 6th cervical vertebra; about ⅜ inch (1 cm.) below this the convex curve of the inferior thyroid artery

FIG. 355.

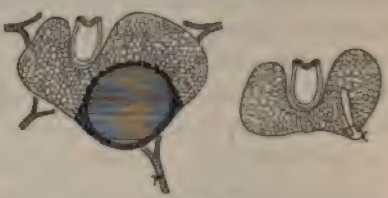


FIG. 356.

can be felt immediately to the inner side of the carotid packet. The artery may be found slightly higher or lower in individual cases. The advantage of his route is that when the sternohyoid and sternothyroid muscles are to the inner side of the line of dissection one is in little danger of opening the fibrous capsule

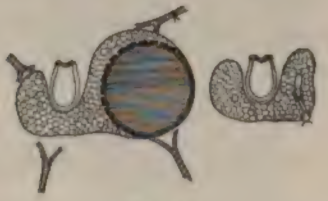


FIG. 357.

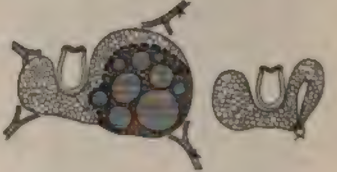


FIG. 358.

of the thyroid and thus one avoids interfering with the numerous veins which lie between the gland and its fibrous capsule.

With suitable retractors gently retract the sternohyoid and thyroid muscles and the thyroid gland towards the median line, the sternomastoid and the outer portion of the sheath of the sternohyoid being at the same time retracted outwards.

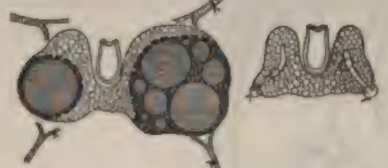


FIG. 359.

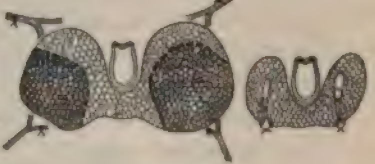


FIG. 360.

With dissecting forceps clear the inferior thyroid artery from the loose connective tissue around it and ligate it. The only vein which interferes in the dissection is the median thyroid and it, as a rule, is at a higher level.

2. The inferior thyroid artery has been ligated, the skin and platysma have been reflected from the whole thyroid region. Make a longitudinal median incision between the two sternohyoid and sternothyroid muscles and penetrate

ɔrous capsule of the gland. In the usual manner dislocate the affected f the thyroid inwards. There will be much less venous bleeding than in sual operation because of the ligation of the inferior artery. From this onwards DeQuervain follows no "hard and fast" method of operating. ding to the needs of the individual case he performs resection, enucleation ɔmbination of these methods, and like most surgeons he always leaves a ıntial portion of the posterior surface of the gland in order to avoid in- the recurrent laryngeal nerve and the parathyroids.

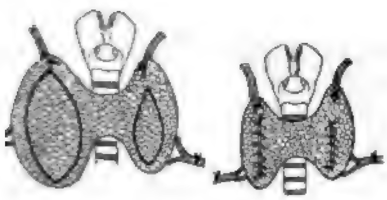


FIG. 361.

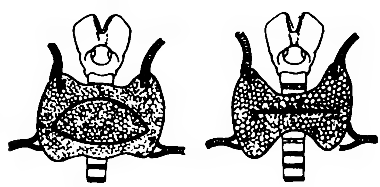


FIG. 362.

ı performing resection the following may be taken as a type: Ligate pper pole of the lobe of the gland to be removed. Note and clamp the ls running over the gland at the chosen site for section (Fig. 363).
ıcise the *true* capsule along the anterior part of the outer surface of the - Make a similar incision through the true capsule to the inner side of ɔbe. Excise all the gland lying between these two incisions, leaving the rior portion of the true capsule with a moderate amount of glandular attached to it.

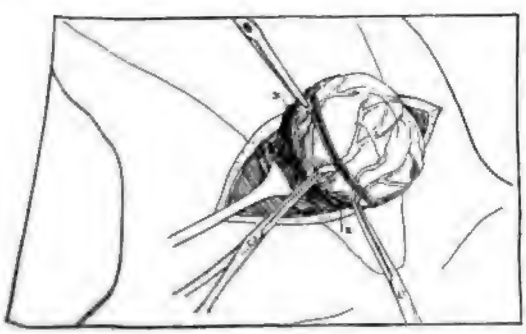


FIG. 363.

o hemostasis. Suture the remnant of the gland close to the wound ing for drainage. Figures 355 to 360 show types of resection. ation is preferable to resection one or several of the thyroid arteries preliminary ligation. Figures 361 and 362 show various types of

Partial Excision—Excision of One Lobe

—Kocher's *Transverse Incision.—Step* 1.—Over the most promi- e tumor make a slightly curved transverse incision (concavity

upwards) from the outer surface of one sternomastoid muscle to the corresponding point on the other. Make the incision too long rather than too short, as thorough exposure is the key to safety. Divide the skin and platysma. Reflect the divided tissues upwards and downwards; the sternohyoid, sternothyroid, omohyoid, and inner margin of the sternomastoid muscles lie more or less exposed. Find the anatomic middle line of the neck. Remember that

FIG. 364.—(*Kocher.*)

a unilateral goitre pushes this line towards the opposite side (Figs. 364 and 372). In the median line divide the fascia uniting the right and left muscle groups. Do this extensively both upwards and downwards under guidance of the finger passed under the fascia. Pass the finger under the muscles of the diseased side immediately below the larynx and, if necessary, divide them transversely to the extent necessary for *thorough* exposure of the tumor.

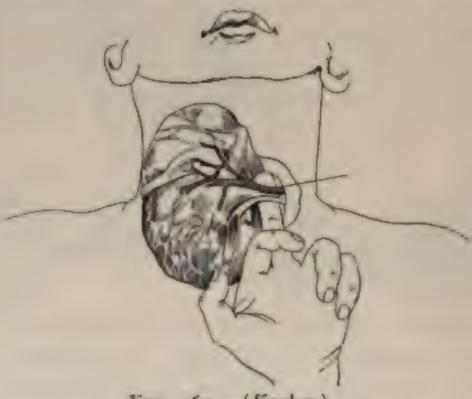


FIG. 365.—(*Kocher.*)

It is well to divide the muscles between clamps so as to prevent staining of the wound with blood. Demonstrate the fibrous capsule of the thyroid and split it without injuring the gland beneath. Division of the fibrous capsule is absolutely essential.

Step 2.—With the finger separate the fibrous capsule from the anterior sur-

f the gland, at the same time pulling the muscles and fibrous capsule rds with blunt retractors. The goitrous thyroid now presents covered eritoneal-like membrane (Fig. 373). Any veins (accessory veins) passing the fibrous capsule to the gland must be doubly ligated and divided. Do me for the outer and posterior surfaces (Figs. 365, 366, and 367). Now ate the goitre and pull it out of the wound. This removes pressure from

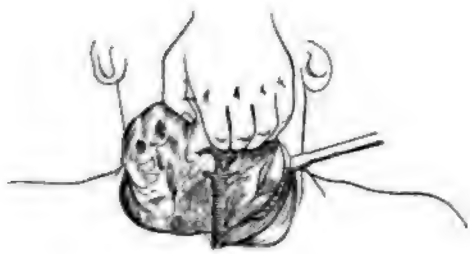


FIG. 366.—(*Kocher.*)

rachea. If a general anesthetic is being used, warn the anesthetist before cating the gland.

tep 3.—Systematic ligation of vessels.

a) With Kocher's director push the fibrous capsule inwards and outwards the upper pole of the thyroid until the superior thyroid artery and vein isolated like a pedicle. Divide these between ligatures applied tightly g. 368).

b) Vigorously retract the muscles (sternomastoid, etc.) of the affected side. ly pull the goitre over towards the sound side (Fig. 367). The inferior

FIG. 367.—(*Kocher.*)

FIG. 368.—(*Kocher.*)

artery lies on the deep muscles of the neck and may be felt as a transverse pulsating cord running from the outer side, under the carotid to the gland, where that structure is attached to the trachea. Isolate the with great care and precision, because close to it is the recurrent laryngeal . Only apply one ligature to the vessel. Many surgeons ligate each of the inferior thyroid ... the gland and so avoid the nerve.

At the lower pole of the tumor on its median side look for doubly

ligate, and divide the thyroidea ima artery and the accompanying veins (Fig. 370).

Step 4.—Isolate the thyroid isthmus. Doubly ligate and divide all vessels visible on it. Catch the isthmus in strong forceps (Fig. 371) and crush it forcibly. Remove the crushing forceps. Doubly ligate the gutter crushed in the isthmus with single or chain ligatures and divide it.

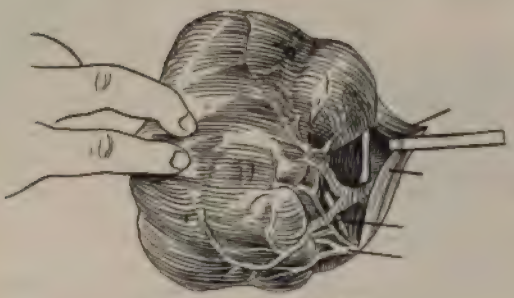


FIG. 369.—(*Kocher.*)

FIG. 370.—(*Kocher.*)

Step 5.—The gland now remains attached to the trachea and cricoid by its inner margin. If this portion of the gland is healthy, cut away the gland in such a manner as to leave a thin layer *in situ*, protecting the recurrent laryngeal nerve. Ligate any bleeding vessels.

Step 6.—Wash the wound with hot solution. Examine for any bleeding

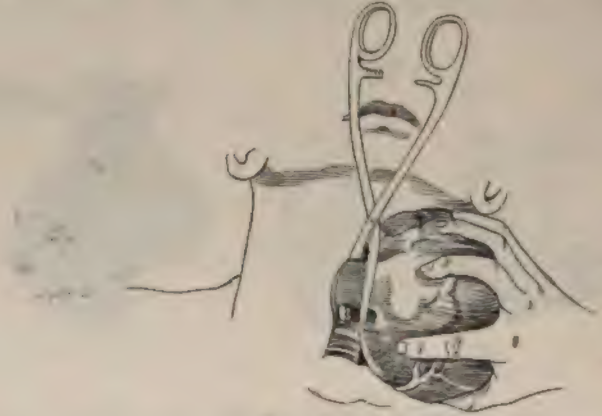


FIG. 371.—(*Kocher.*)

points. Return any divided muscles to their normal place and unite them by sutures. Provide for drainage, especially in exophthalmic cases. Close the wound. Apply dressings. The drainage must be removed in twenty-four hours if no fluid blood is escaping.

Method B.—Mayo's Operation.—Step 1.—As in method A.

Step 2.—With the fingers separate the fibrous capsule from the anterior surface of the gland, at the same time pulling the muscles and fibrous capsule outwards with blunt retractors or forceps. Doubly ligate and divide any accessory veins. Expose and elevate the upper pole of the thyroid; doubly ligate and divide the superior thyroid vessels.

Step 3.—Elevate the lower pole of the thyroid and bring it into the wound. If necessary make an incision along the outer posterior border of the thyroid so as to divide any condensed areolar tissue which may be adherent to the peritoneal-like investment of the gland. This incision is not always necessary.

FIG. 372.—(*Mayo.*)

With a piece of gauze wipe or brush all areolar tissue adherent to the posterior surface of the gland from the gland so that that surface of the gland has no *moss* of areolar tissue left adherent to it, but presents a smooth peritoneal-like appearance. If this is done carefully and every bit of areolar tissue, which may have penetrated into sulci on the gland surface, has been brushed off and left adherent to the fibrous capsule, then the parathyroids must also have been brushed off and preserved. Continue this gauze dissection or brushing to the middle line. Ligate the inferior thyroid artery close to the tumor as the gauze

dissection is being carried out. This leaves the recurrent laryngeal nerve behind and usually out of sight.

Steps 4, 5 *and* 6.—As in method A.

Method C.—Halsted's operation is the same as Kocher's or Mayo's up to a certain point. The following quotation from Halsted gives the main points of his method. "Contrary to the universal custom, I do not, as a rule, complete at this moment the full delivery of the entire gland, for fear of soiling, but grasp very firmly between the thumb and finger the superior pole and pull it forwards and towards the mid-line far enough to make the ultraligation of the

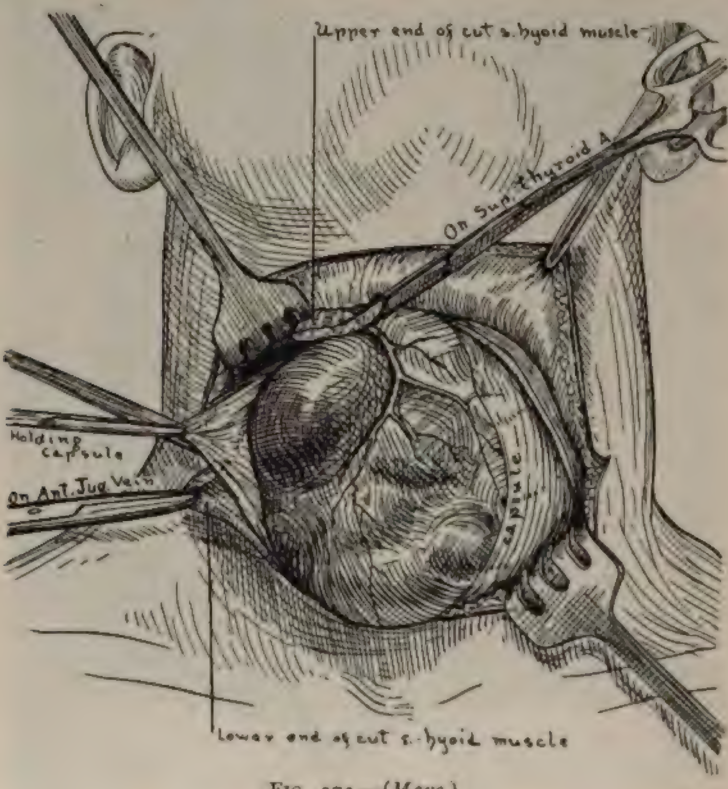


FIG. 373.—(*Mayo.*)

superior thyroid vessels perfectly easy. Attempts to completely dislocate the entire gland or the inferior pole in this manner at this stage of the operation may cause the rupture of some delicate blood-vessels and consequent staining of the field containing the parathyroid glandules. But, if judiciously done in the manner described, the superior pole may be fearlessly grasped, because at this horizontal level there are no vessels behind the superior pole to be torn. When the superior thyroid vessels have been safely passed by the thumb or finger, one may proceed with considerable roughness and without fear of hemorrhage to dislocate even the highest and deepest superior pole. This grasp of

the upper portion of the lobe, putting on stretch the superior thyroid vessels, must not be relinquished until released by the ultradivision of the finest branches distributed to the thyroid gland in the vicinity of the superior pole. The upper end being thus liberated the delivery of the entire lobe is continued, and without the tearing of the blood-vessels. From this step on, throughout the operation, until the last vessel has been divided, the thyroid lobe must be firmly drawn towards the opposite side, alternate relaxation and compression and undue pressure on the trachea being carefully avoided. From above downwards and from before backwards the vessels as they bind or as they present must be clamped and divided at their point of entrance into the gland, as far peripherally as possible. Except in the case of the larger branches it is usually unnecessary to clamp the distal end of the cut vessel, hemorrhage from the gland side being prevented by the pressure exerted on the thyroid lobe by the unremitting traction towards the opposite side of the neck. By this method the recurrent laryngeal nerve, usually seen, is little endangered. In the course of the liberation of the lobe the nerve may be dragged well to the front of the trachea; of the right nerve this is particularly true. When in the immediate neighborhood of this nerve, at what might erroneously be termed the hilus of the thyroid lobe, one plunges the sharp-pointed clamps into the thyroid gland, seizing the binding vessels after they have disappeared from view in its substance. When the habit is well acquired, little if any time is lost by practising the clean, bloodless method of operating for goitre. The operation can be carefully performed in about the time required for its detailed description."

Method D.—Angular Incision (*Kocher*).—Beginning on the sternomastoid muscle at the level of the thyroid cartilage, make an incision through the skin and platysma, reaching the median line and following the direction of the natural folds or creases of the skin. Continue the incision downwards in the middle line to the notch of the sternum. Reflect the angular skin-flap and expose the sternomastoid, which must be retracted outwards. The rest of the operation is the same as in Method A. This method of exposure is of much value in cases where the goitre extends far upwards or downwards.

Method E.—V. Mikulicz's Method of Resection.—The following description is from v. Mikulicz's article, quoted by Berry ("Diseases of the Thyroid Gland"): "I began the operation, intending to perform the ordinary one of removal of the left lobe, and hoping to be able to leave the right intact. In the course of the operation, however, it became evident that the right lobe lay partly behind the sternum, and would, if left, prove a source of danger to the patient. So instead of doing the usual extirpation, I resected this lobe in the following manner: First of all it was isolated as far as possible in the usual way with blunt instruments. The smaller blood-vessels were tied with double catgut sutures. I then tied the superior thyroid artery and vein in the ordinary manner at the summit of the lobe; also the superficial vessels passing to the lower part of the gland. I now, by means of short snips of the scissors, freed that portion of the tumor which was adherent to the front and side of the trachea, but took care not to go too far back, so as not to come into collision with the recurrent laryngeal nerve.

Eventually the whole tumor was attached only to the angle between the trachea and œsophagus, where it covered the recurrent nerve and inferior thyroid artery. This attached portion, the hilus of the gland, I treated like the short, thick pedicle of an ovarian tumor. . . . While my assistant with his fingers compressed the vessels entering the hilus, I split the pedicle lengthwise with blunt scissors into several portions, seized each of these in a strong pair of pressure forceps, and placed catgut ligatures in each of the clefts so formed. Then the goitrous mass was cut off with scissors, leaving a pedicle of 5 to 10 mm. (1/5–2/5 inch) in length. The forceps squeezed out nearly all the glandular tissue, leaving in their grasp little but connective tissue. The result was that the catgut ligatures could easily and safely be placed around the separated portions of the pedicle. Not a drop of blood came away from the cut surfaces; only here and there in the intervals was a little oozing; this slight hemorrhage was easily stopped by the application of a few ligatures. The remainder of the gland had now shrunk to a lump

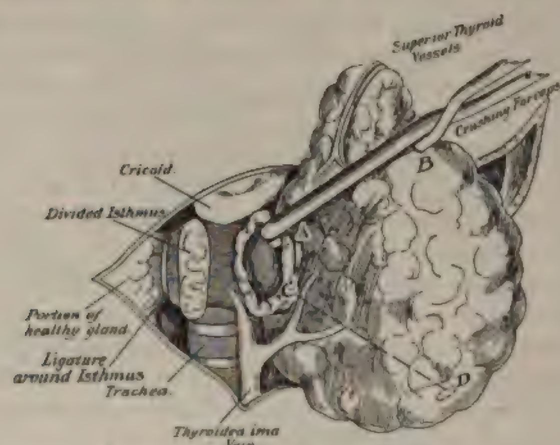


FIG. 374.—Resection-enucleation.

about as large as a chestnut which lay in the angle between the trachea and œsophagus. Neither recurrent nerve nor inferior thyroid artery came into view on this side."

The above operation has been frequently repeated and has proved very successful. The advantages of the procedure are: (*a*) avoidance of the recurrent nerve; (*b*) avoidance of injury to the parathyroids; (*c*) retention of portions of the lobes attacked, and hence the possibility of removing parts of both lobes.

Donald Balfour (Annals Surg., May, 1914) describes a method almost the same as that of Mikulicz. It is particularly suitable for non-toxic goitres where the operation is for the relief of pressure symptoms and the removal of deformity.

Expose the thyroid through the usual collar incision. If both lobes are enlarged, dislocate them both. Determine how much glandular tissue must be removed from each side to ensure symmetry and cure. Divide the isthmus, if possible, between clamps. Free the isthmus and lobe on one side from their

tracheal attachments anteriorly and laterally sufficiently to relieve all pressure and to permit of proper suturing after resection. Do the same to the other half of the gland.

Apply a series of Ochsner forceps around the area to be resected: one forceps about 1 inch from the upper pole, one near the lower pole, three or four laterally

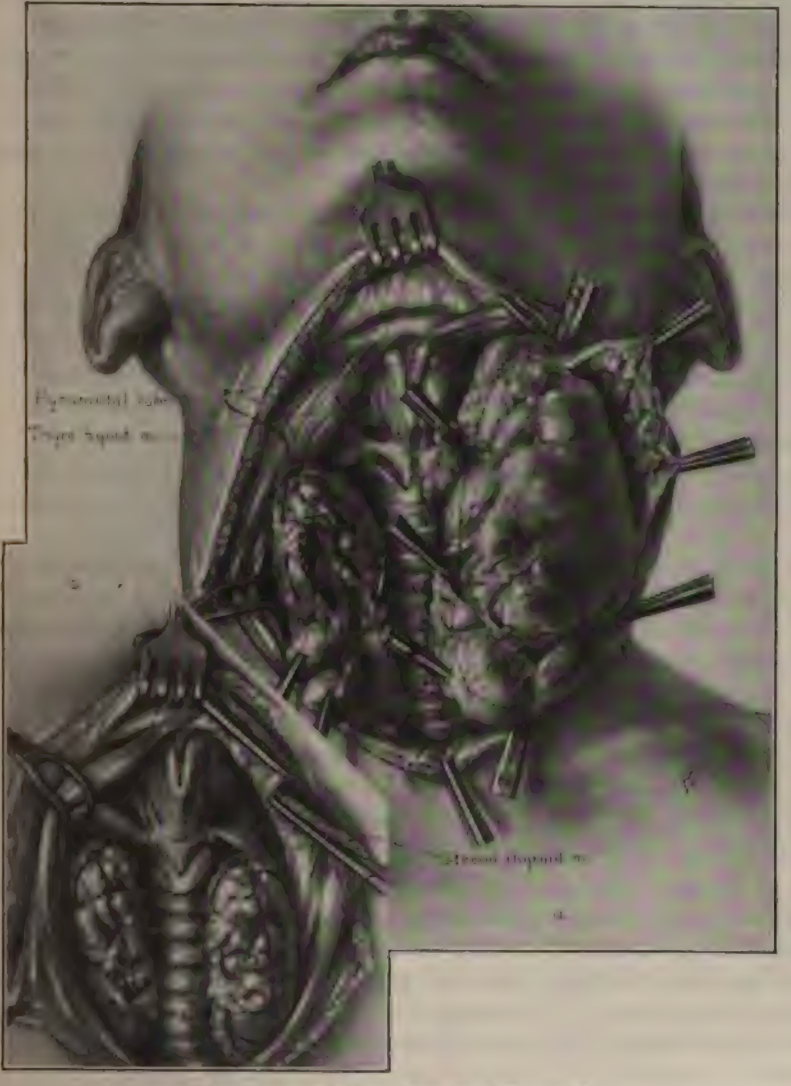


FIG. 375.—(*Balfour, Annals of Surgery.*)

on the larger vessels in the capsule, and two or three on the tracheal side. These forceps mark the limits of the resection and enable one to control bleeding by traction on them along with support of the lobe from behind with the finger. Make an incision through the capsule around the lobe just within the circle of

forceps (Fig. 375). "Wedge" out the interior of the gland. Multiple adenomas and masses of colloid are easily enucleated by the finger. The superior and inferior poles and a layer of gland tissue covering the posterior capsule are left intact. Bring the walls of the wounded gland into contact and fix them together by a continuous mattress suture of catgut introduced behind the row of Ochsner forceps. Remove the forceps. Introduce sufficient stitches to complete the closure of the glandular wound and to assure hemostasis.

Method F.—Resection-enucleation (*Kocher*).—This method is very like that of v. Mikulicz, but avoids leaving large ligated masses near the location of the recurrent nerve. Kocher has noticed that when many large pedicles are ligated near the nerve the necessary contraction of the tissues by the ligature often causes injury to it.

The Operation.—Step 1.—Expose the anterior surface of the diseased half of the thyroid as in Method A. Crush (with forceps), ligate, and divide the isthmus close to the disease.

Step 2.—Through the cut surface of the isthmus the goitrous nodule will present (Fig. 374). Beginning at the isthmus wound, with the finger or Kocher's director penetrate the glandular capsule down to the disease and separate the former from the nodule along the lines A B and C D. Note that the separation of glandular capsule from goitrous nodule is only along these two lines. With strong forceps crush the glandular capsule along the lines of separation, remove the forceps, apply ligatures to the crushed tissue, and divide the glandular capsule.

Step 3.—Grasp the goitrous nodule and overlying glandular capsule and separate this mass from the posterior portion of the glandular capsule until all that connects the goitrous mass to the body is the outer portion of the glandular capsule (B D, Fig. 374) well external to the line of the recurrent nerve. Crush this portion of the capsule; ligate and divide it.

By the above procedure the diseased tissues are removed, and with them the anterior portion of the gland. All the posterior surface of the gland is left, which is advantageous because danger to the recurrent nerve, and the parathyroids, is avoided and much useful glandular tissue is retained. Hemorrhage is less than in enucleation. Kocher says that this operation, while very valuable, is of more limited application than excision. It is inapplicable in cases of diffuse follicular colloid degeneration.

Method G.—Freeman's Method (Surg. Gyn. and Obst., July, 1914).—Dislocate the gland through the usual collar incision. Separate ligation of the superior thyroids may be practised if desired. Pull the lobe forwards so as to put its attachments on the stretch and form more or less of a pedicle next to the trachea.

Thread *both* ends of a 12-inch loop of strong silk or fishing line through the eye of a probe and pass it from behind forwards through the substance of the gland near its attachments.

Introduce several such loops of thread through the gland, one near each end and one or more near the center. Place a segment of strong wire (No. 17

German silver, "orthodontia wire") through the loops behind the gland and a similar wire between the ends of the thread in front of the gland. Tie the threads over the anterior wire firmly enough to control the circulation without injuriously crushing the glandular tissue. About ½ inch distal to the wires cut away the lobe in a more or less wedge-shaped fashion. Suture the wound with a continuous catgut stitch to cover the raw surface and prevent subsequent bleeding. Pull the wires out of the loops and remove the latter. Close the wound as usual. Freeman has used this method successfully in about twenty goitres of moderate size and excessive vascularity—as in Graves' disease.

II. INTRAGLANDULAR ENUCLEATION

Step 1.—Expose the anterior surface of the diseased lobe by Method A or or D. (See "Excision.")

Step 2.—Note the most prominent part of the tumor, and at this point freely incise the glandular capsule. Before incising, clamp or doubly ligate any prominent vessels. Be sure to penetrate to, but not into, the tumor. It is not always necessary to incise the glandular capsule as the tumor may have so grown as to push aside all the gland tissue which originally covered it. In such a case it is easy to enucleate the growth by brushing aside with gauze all tissue adherent to it.

Step 3.—With blunt dissection, using the finger, Kocher's director, or closed blunt scissors, shell the tumor out of its glandular capsule. Sometimes this is more easily accomplished if the fluid contents are drawn off, as in the case of a large ovarian cyst. The shelling-out must be done rapidly, as bleeding is often abundant. The surgeon must always keep his instrument close against the tumor-wall, otherwise the vascular glandular capsule will be injured and more bleeding provoked.

Step 4.—Immediately on the removal of the tumor temporarily pack the cavity with gauze and pull the whole cavity forwards. Gradually remove the gauze, and with forceps, ligatures, and catgut stitches stop hemorrhage. The hand placed behind the thyroid can press the floor of the wound cavity forwards within reach and control. Hemostasis must be absolute, as primary union is of great importance.

Step 5.—Provide for drainage for twenty-four hours. A tubular drain is best. Close the wound with sutures. For this purpose Berry uses three layers of fine sutures. One layer obliterates the cavity in the gland, another unites the muscles, and a third, the skin-wound.

Where large multilocular cysts are present F. J. Shepherd ties and divides the superior thyroid vessels, delivers the gland and enucleates the tumor. This leaves a thin layer of gland tissue behind, and there is no danger of injuring the recurrent nerve. Occasionally Shepherd ties the inferior thyroid as well as the superior. In the light of Evans' researches into the blood supply of the parathyroids, ligation of the inferior thyroid artery becomes a matter of much greater gravity than it was formerly thought to be.

III. INCISION AND EVACUATION; MARSUPIALIZATION

In certain cases of cystic goitre where repeated attacks of inflammation have caused the formation of many adhesions none of the preceding methods are applicable, and a simpler operation must be done.

Step 1.—Make an incision over the most prominent portion of the tumor and expose a few inches of its surface.

Step 2.—Doubly ligate the vessels of the tumor capsule (both fibrous and glandular capsule) and incise the tumor. Stitch the edges of the wound in the cyst-wall to the skin.

Step 3.—Explore the cyst with the finger and shell out all degenerated colloid masses. Stop bleeding by means of forceps, ligatures, hemostatic sutures, hot water, and packing. Drain the cavity.

The great objection to this procedure is the open wound which is left, the dangers of subsequent infection, and the possible persistence of a fistula; its advantages are ease of accomplishment and immediate safety. The operation has a distinct though limited field of usefulness.

IV. TRANSPLANTATION OF THYROID OR PARATHYROID GLANDULAR TISSUE

Payr ("German Surg. Congress," 1906) has made some remarkable experiments on animals and has endeavored to prevent the tetany and cachexia strumipriva which follow complete thyroidectomy. In animals he implanted fragments of thyroid gland into a pouch made in the spleen. Hemorrhage ceased as soon as the "living tampon" was sutured in place. Omentum was stitched over the splenic wound. After some days the rest of the thyroid gland was removed without ill resulting. As a control Payr in some cases subsequently removed the spleen and caused death from tetany.

Encouraged by the above Payr operated on a girl of six years, a complete idiot who had been treated for three years with thyroid tablets unsuccessfully. He removed a part of the healthy thyroid from the patient's mother and immediately implanted it in the child's spleen. Both patients recovered from the operation. The psychic improvement in the child was "incontestable." Payr has noticed that grafts from ductless glands generally do well in the spleen while those from excretory glands do not do so well.

Following Payr's lead, Halstead has endeavored to transplant parathyroid glands which have been accidentally deprived of their vascular supply during strumectomy.

In a case of tetany following thyroidectomy a cure resulted from the implantation of two parathyroid bodies under the skin of the abdomen. The implants were obtained from two men operated on for goitre. (W. Davidson, "Beitr. z. klin. Chir.," lxvi, Hft. 1.)

V. INJECTIONS OF BOILING WATER

(Miles Porter, "Journ. A. M. A.," July 12, 1913)

Any fairly large all-glass graduated syringe may be used. The glass barrel prevents one from injecting air; the more water the syringe holds the less rapidly will the water cool; the plunger and barrel being both of glass prevents binding or breaking due to unequal expansion. The needle ought to be long and rather fine.

Boil the syringe and needle in the water to be used for injection and keep the water boiling until the time of injection. When more than one injection is given at a treatment, reboil the syringe immediately before the next injection to insure having the water used as near the boiling point as possible.

Handle the syringe with long forceps (the points of which have been heated) and with sterile gauze or muslin. After cleaning the skin anesthetize it at the site of injection, with Schleich's solution. Avoiding any large superficial veins pass the long needle deeply into one lobe and inject the boiling water. Porter has used from 40 to 230 minims at one injection. Partly withdraw the needle and make another injection. With the long needle it may be possible to make two injections into each lobe and one into the isthmus through the same puncture. The discomfort produced by the treatment is usually slight and consists of a feeling of distension and of pain running up to the occiput. In some cases the pain has been severe. The goitre usually becomes larger and harder following the injection but later on decreases much. The improvement in symptoms is usually prompt and progressive for one or two weeks. The injections should be repeated at intervals of one or two weeks. The greatest number of injections given any one patient was eleven. Porter has used the treatment chiefly in three classes of cases: 1. Patient too sick to make a safe surgical risk. Cases also of substernal goiter, the removal of which would be extra hazardous. 2. Patients with very mild symptoms. 3. When major surgical procedures have been refused.

The author has had no personal experience in the "boiling water" treatment of exophthalmic goitre, but Porter who devised it is a most reliable surgeon and his findings have been amply corroborated by others.

CHAPTER XXIX

THYMUS GLAND

An enlarged thymus gland may so press upon the trachea as to necessitate operation. Operation may be either exopexy with or without partial excision or it may be one of complete excision.

The thymus and thyroid glands being both branchiogenous organs may be simultaneously affected by the same influences. Thus the *cause* of Graves' disease may act on *both* these glands and the biochemical activity of each may have its effect on the production of the symptoms. Klose thinks that the fact that thyroidectomy only gives 70–80 per cent. of cures in Graves' disease, indicates that there is another source of toxin than the thyroid, viz., the thymus. (See H. Klose, "Chir. der Thymus-drüse. Ergeb. d. Chir.," viii, 1914.)

The work of Garré ("Zent. f. Chir.," Dec. 6, 1913) has demonstrated that the thymus *may* be responsible for the symptoms of Graves' disease. He reported the following case: Woman twenty-seven suffered for three months from marked Basedow's disease with severe diarrhœa. The trouble followed a gynecologic operation. The thyroid gland was scarcely enlarged; there was dulness over the manubrium sterni; lymphocytosis 46 per cent.; functionally increased vagotonus; negative adrenalin test; fall of leucocytosis to normal and marked increased elimination of nitrogen under a milk diet; increase of the symptoms after intramuscular injections of thymus extract. All these led Garré to remove the thymus. The results were excellent. The diarrhœa stopped at once. In six weeks the pulse rate dropped to below 100. The weight increased 19 pounds. The exophthalmos, sweating and tremor lessened. The blood picture remained unaltered.

v. Haberer (German Surg. Congr., 1913) reported the case of a man suffering from exophthalmos, enlarged thyroid, violent and increasing tachycardia. Hemithyroidectomy did not benefit—neither did ligation of the vessels on the opposite side which was done two years later. When v. Haberer saw him his condition was precarious from dyspnœa and tachycardia. Immediate improvement followed thymectomy under local anesthesia, although the thymus itself proved to be very small. Four months after operation the patient was able to return to work and was free from dyspnœa, tachycardia and nervousness.

Since it is very difficult, even if possible, to define in which cases the thymus is the principal offender Klose recommends combined excision as the operation of choice in Basedow's disease especially in those cases in which fear of a "thymus death" formerly contraindicated operation. He claims (and is supported by Enderlen and v. Haberer) that removal of part of the thymus makes the operation of strumectomy for exophthalmic goitre much less dangerous and distressing as well as giving surer ultimate results.

Regarding the technique of the operation Klose writes, "It is possible in every case under local anesthesia to pull forwards the thymus bluntly after splitting the deep fascia and then to incise the capsule and enucleate the gland completely or in part. Experience has shown that complete removal is harmless in adults. The enucleation must of course be intracapsular. . . . v. Haberer urges that the posterior surface of the sternum be used as a guide in order to avoid trouble."

A. Exopexy.—Expose the upper part of the thymus gland by a median incision above the sternal notch. Pull the gland upwards and forwards. Anchor it with a few stitches to the fascia over the sternum. In the hands of Rehn, exopexy gave a good result. In a similar case Fritz König resected a portion of the gland, anchoring the remainder to the sternum, and obtained a cure of the dyspnœa.

B. Excision of the Enlarged Thymus. (Ehrhardt, "Archiv für klin. Chir.," lxxviii, 602.)

Step 1.—Make a median incision from a point just below the larynx to a point about ½ inch below the upper edge of the sternum. Layer by layer divide the tissues, including the isthmus of the thyroid, until the trachea is fully exposed. At each expiration a large part of the thymus rolls forward in the root of the neck.

Step 2.—Seize the thymus with forceps and pull it forwards. Enucleate the gland by blunt and sharp dissection attending to hemostasis at the same time. Partially tampon and close the wound.

Ehrhardt operated with success as above in one case.

Veau and Olivier ("Arch. de méd. des. enfants," 1910, Nov.) operated in three cases in much the same manner using chloroform narcosis. After exposing the gland and fixing it with forceps they penetrated the capsule first on the left side and enucleated the gland, then they did the same on the right side, and closed the cavity with catgut sutures. Veau and Olivier performed total extirpation as above described without ill effect, but if one fears removal of the whole gland one may content oneself with the removal of one half. ("La Presse Méd.," ix, 1910.)

The surgeon must remember that the thymus gland may cause death from pressure without the presence of any visible or palpable tumor in the neck.

Chevalier Jackson ("Jour. Amer. Med. Assoc.," May 25, 1907) has demonstrated an enlarged thymus by means of the X-rays, and with the bronchoscope showed that pressure from the thymus produced scabbard deformity of the trachea. After tracheotomy Jackson measured the distance from the tracheotomy wound to a point 1 cm. from the bifurcation of the trachea and procured a tracheotomy cannula of this length. The use of a cannula passing through the constricted trachea notably facilitated the removal of the thymus.

PART II.—THE THORAX

CHAPTER XXX

OPERATIONS ON THE BREAST

Evacuation of Abscess by Incision.—The classical method of incising the breast to empty an abscess is exceedingly simple. Make an incision through the skin, beginning peripheral to the *areola*, along a line radiating from the nipple and situated over the inflammatory swelling. By combined sharp and blunt dissection penetrate the abscess, clean the cavity, and provide drainage. The object of radial incision is to avoid transverse and unnecessary division of glandular structures.

An abscess forming in the breast itself may break through to the subcutaneous or to the submammary areolar tissues. The communication between the primary focus and the secondary abscess may be narrow. Several foci of pus may be present and only communicate with each other through narrow passages. To effect drainage and avoid all deformity Morestin operates as follows:

From the base of the nipple to the edge of the areola (fortunately the areola is usually wide spread in lactating women) make an incision through the skin. From this incision pass the knife subcutaneously into the superficial collection of pus. In withdrawing the knife enlarge the opening but do *not* cut through the skin beyond the areola. With a probe, forceps, or even the finger, explore the abscess and find the communication between it and the intramammary focus. With the knife enlarge this communication so that drainage will be free. If any other foci of pus are present penetrate them in similar fashion. Cleanse and antisepticize the abscess. Introduce drains and apply dressings.

No matter the site of the abscess, above, below, internal or external the operation is the same. Bleeding is trivial and ceases spontaneously in a few minutes. Usually the drain may be removed in from three to five days and recovery ensues in ten to twelve days. The scar is hardly noticeable.

To avoid deformity from scars it has been suggested to use the principle of Thomas' operation for adenomata of the breast. Make a curved incision along the line of junction of the lower edge of the breast and the chest-wall. Penetrate to, but not through, the pectoral fascia. Separate the breast from the chest-wall until it is possible to gain access to the abscess from the deep surface of the gland. Evacuate the pus. Introduce one or two drainage-tubes into the cavity and br[illegible]nds out through the wound. Replace the mamma on the thora[illegible]lly close the skin-wound by sutures.

In this operation the incision is larger and the dissection is much greater than is required in simple incision, but the drainage is excellent and the resulting scar is below the breast and hidden by the natural fold existing there.

Mastopexy.—Mastoptosis or pendulous breast is common, may be due to one or several of many causes, may be harmless except as a disfigurement, but it may give rise to chronic, painful engorgement and to various inflammations. Ch. Girard ("Archiv für klin. Chir.," xcii, 829) describes the various methods of treatment adopted for mastoptosis and suggests an operation which he has successfully used.

Step 1.—Reflect the breast upwards, as in the Thomas' operation for benign neoplasms, until the second costal cartilage is reached.

Step 2.—Expose the second costal cartilage by incising the pectoral fascia and bluntly splitting the pectoralis major muscle parallel to its fibres.

Step 3.—With a slightly curved, strong needle pass a very strong catgut suture from below upwards through the second costal cartilage. Pass this suture through the fibrous tissue of the upper pole of the mamma. Tie the suture after tightening it sufficiently to bring the breast up into the desired position but still leaving the loop of the suture somewhat open like a sling. Through the loop of the first suture pass about four catgut threads and stitch each of these to different parts of the under surface of the breast. The result of the above procedures is that a number of radiating threads pass from the primary suture in such a manner that all parts of the breast are attached to the second costal cartilage by a series of slings, but the breast can still be lifted up from the chest wall.

Step 4.—From above downwards suture the under surface of the mamma to the pectoral fascia.

Step 5.—Close the skin wound.

Excision of Non-malignant Neoplasms of the Breast.—I. When the breast is the seat of very large or multiple non-malignant neoplasms, the whole organ must be excised, but it is not necessary to remove the pectoral fascia or axillary contents. Make an oblique elliptical incision over the breast and including the nipple. This incision runs from above and outwards, downwards, and inwards; it begins and ends just beyond the confines of the gland. Through the incision dissect the skin free from the breast; by blunt and sharp dissection separate the breast from the pectoral fascia and remove it. Attend to hemostasis. Close the wound.

The operation is perhaps the easiest in surgery. When there is doubt as to the malignancy or non-malignancy of the disease present, and histological examination is, for any proper reason, not convenient, then the above operation should *not* be performed; the patient ought to be given the benefit of the doubt and radical measures adopted.

II. When the breast is the seat of one or perhaps of two or three small non-malignant neoplasms, such may be excised, leaving the gland practically intact.

Method A.—Fix the neoplasm by grasping it between the finger and thumb. Make an incision over the tumor, peripheral to the nipple areola, along a line

radiating from the nipple. Expose the tumor by this incision and either shell or dissect it out of its bed. Attend to hemostasis. Close the wound, with or without drainage.

Method B.—Thomas' operation has the great advantage of avoiding visible scars. It has been sufficiently described on page 277.

Excision of the Breast for Cancer.—A few years ago typical excision of the breast could be completed in a few minutes. The operation consisted in making an elliptical incision over the breast, including the nipple, in rapidly reflecting the skin from the gland, and in tearing and cutting the gland from the pectoral fascia. Through the wound the finger was pushed up into the corresponding axilla, and if any lymphatic glands were found enlarged, such were removed. The operation was primarily safe. The ultimate results were such that many experienced surgeons claimed recurrence always took place. Disgusted with the want of success attained, thoughtful operators became more radical and more successful. The typical operation no longer consisted in removal of the mamma and the axillary glands if they were palpably diseased, but the mamma, the pectoral fascia, the axillary glands, and fat were removed in one piece. The primary mortality of the operation did not increase perceptibly; the ultimate results were infinitely bettered.

The Operation.—The incision A, B, C (Fig. 376) is made through the skin. The ellipse between B and C includes the nipple and any portions of skin which may be adherent to the tumor. The skin-flap A B C E is reflected downwards well below the limits of the breast and to the posterior border of the axilla (*i.e.*, to the edge of the latissimus dorsi). The skin-flap A B C D is reflected upwards well above the limits of the breast and so as to expose the anterior boundary of the axilla. Beginning below the breast, one dissects from the pectoralis major, the fat of the chest-wall, the pectoral fascia, and with them the diseased mamma. This is continued to a point well above the breast, to the base of the skin-flap A B C D.

FIG. 376.

There is now a mass of fat, gland, and pectoral fascia *unconnected* with the chest-wall, but *continuous* with the fatty and lymphatic axillary contents. The chest wound is to be protected by an aseptic pad or towel and the surgeon attacks the axilla. Beginning on the *outer* or arm side of the axilla, its fatty contents are dissected from the vessels and nerve-trunks there situated. The first effort should be to dissect the axillary vein free from its fatty surroundings. Any axillary branches of the vein should be divided between two fine ligatures whenever found. When this dissection is being made, the arm should be kept as close to the body as is consistent with free access to the axilla; the object attained by doing so is that otherwise branches of the axillary vein would be put on the stretch and rendered unrecognizable, and further that in this position it is possible to retract the pectoralis major upwards, thus giving access to the apex of the axilla.

The contents of the axilla are easily separated from the posterior and internal walls of the space. If it is convenient to save the small nerves crossing the axilla, they may be preserved; but if, as is usually the case, time would be lost in so doing, they should be sacrificed. The only connection left between the mass to be removed and the body is at the apex of the axilla. If the lymphatics higher up are believed to be healthy, this connection is divided and the excision is complete. If, on the other hand, it is suspected that the disease extends further, then the pectoralis major is divided and access is gained to the chain of lymphatics running up under the clavicle. These are removed in one piece with the tumor mass. The wound in the muscle is sutured. The whole wound is closed, axillary drainage being provided.

When the pectoral fascia is being removed from the pectoralis major, should any disease be found or suspected to exist in that muscle the whole muscle must be excised in one piece with the mamma.

The operation, as described, is not one for a novice, but in the hands of an experienced surgeon it is safe and has given results which, when compared to those previously obtained, might almost be described as brilliant. Halsted has still further elaborated the operation, making it *tremendously* extensive and most remarkably successful. His success is so great that the author considers the Halsted operation or some modification thereof to be the preferable treatment for operable mammary cancer.

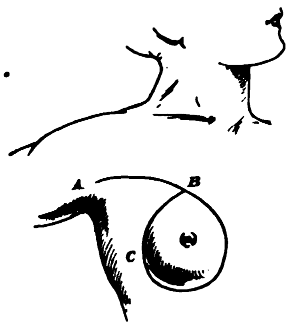


FIG. 377.—Halsted's incision.

Halsted Operation.—(The following description is compiled from Halsted's articles in the "Annals of Surgery," vol. xx, No. 5, and xxviii, No. 5.)

Principles of Operation.—The pectoralis major muscle, entire or all except its clavicular portion, should be excised in every case of cancer of the breast, because the operator is enabled thereby to remove in one piece all the suspected tissues. The suspected tissues should be removed in one piece.

Step 1.—The skin-incision is carried at once and everywhere through the fat (Fig. 377).

Step 2.—The triangular flap of skin A B C is reflected back to its base line, C A. There is nothing but skin in this flap. The fat which lined it is dissected back to the lower edge of the pectoralis major muscle, where it is continuous with the fat of the axilla.

Step 3.—The costal insertions of the pectoralis major are severed and the splitting of the muscle, usually between its clavicular and costal portions, is begun, and continued to a point about opposite the scalenus tubercle on the first rib.

Step 4.—At this point the clavicular portion of the pectoralis major and the skin overlying it are cut through hard up to the clavicle. This cut exposes the apex of the axilla.

Step 5.—The loose tissue under the clavicular portion of the pectoralis

major is carefully dissected from this muscle as the latter is drawn upwards by a broad sharp retractor. This tissue is rich in lymphatics *and is sometimes infected with cancer.*

Step 6.—The splitting of the muscle is continued out to the humerus, and the part of the muscle to be removed is now cut through close to its humeral attachment.

Step 7.—The whole mass, skin, breast, areolar tissue, and fat, circumscribed by the original skin incision, is raised up with some force, to put the submuscular fascia on the stretch as it is stripped from the thorax close to the ribs and pectoralis minor muscle. It is well to include the delicate sheath of the minor muscle when this is practicable. This step has been modified by Halsted in that he now ("Annals of Surgery," Nov., 1898) removes the pectoralis minor and exposes the subclavian vein at its inner part.

Step 8.—The axilla is now stripped of its contents and its anterior wall at one time, from within outwards and from above downwards. The axillary contents are dissected away with scrupulous care and with the sharpest possible knife. The axillary vein should be stripped absolutely clean. Not a particle of extraneous tissue should be included in the ligatures which are applied to the branches, sometimes very minute, of the axillary vessels. In liberating the vein from the tissue to be removed it is better to push the vein away from the tissues rather than, holding the vein, to push the tissue away from it. It may not be necessary, but it is well to expose the artery and remove the possibly infected tissue above it. It is best to err on the safe side and remove in all cases the loose tissue above the vessels and about the axillary plexus of nerves.

Step 9.—Having cleaned the vessels, we may proceed more rapidly to strip the axillary contents from the inner wall of the axilla—the lateral wall of the thorax.

Step 10.—When we have reached the junction of the posterior and lateral walls of the axilla, or a little sooner, an assistant takes hold of the triangular flap of skin and draws it outwards, to assist in spreading out the tissues which lie on the subscapularis, teres major, and latissimus dorsi muscles. The operator cleans the posterior wall of the axilla from within outwards. The subscapular vessels are exposed and caught before being divided. The subscapular nerves may or may not be removed.

Step 11.—Having passed these nerves, the operator has only to turn the mass back into its normal position and to sever its connection with the body of the patient by a stroke of the knife from B to C, repeating the first cut through the skin.

Step 12.—This step did not belong to Halsted's original operation, but has been added by him subsequently. Make a vertical incision parallel to and near the posterior margin of the sternomastoid muscle, dividing a few of the posterior fibres of the muscle. Expose the junction of the internal jugular and subclavian veins. Divide the omohyoid muscle at its tendinous part and draw its two bellies out of the way. Remove the supraclavicular fat by dissecting downwards and outwards from the venous junction, and the infraclavicular

fat by dissecting from below. By elevating the shoulder the clavicle can be raised an inch or more away from the first rib when the operation is so far completed as to make this desirable. The web of fibrous tissue which binds the subclavian vein loosely to the clavicle is thus spread out and can be easily removed. The fingers can be passed from the supraclavicular to the infraclavicular and to the subscapular regions under the clavicle, and any fat in the latter region, near the internal or the posterior border of the scapula between the serratus magnus and subscapular muscles, which could not be well reached from the axilla can be drawn out through the neck.

FIG. 378.—Kocher's incision.

FIG. 379.—(*Kocher.*)

Step 13.—Review the whole wound. Unite the divided omohyoid by a catgut suture. Close the wound in the neck. The edges of the chest wound are approximated by a buried purse-string suture of strong silk. Of the triangular flap of skin (A B C, Fig. 377) only the base is included in this suture. The rest of the flap is used as a lining for the fornix of the axilla. The axilla is never drained. The open wound remaining on the chest is immediately covered with Thiersch's skin-grafts.

Many surgeons, the author included, have devised almost identical operations for removal of the breast and have found such satisfactory.

Kocher's description of the operation is so excellent that it will be used as the basis of the following paragraphs. To Willy Meyer, however, belongs the credit of the radical breast operation in which the dissection of the lymphatics precedes the removal of the mamma. Meyer's operation was devised totally independently of Halsted's and was published during the same month as Halsted's.

Step 1.—With the knife make a few superficial scratches on the skin to mark out the line of incision which is shown in Fig. 378. From the clavicle to the edge of the anterior axillary fold near the insertion of the pectoralis major, complete the incision through the skin, subcutaneous tissue, and fascia. Expose the cephalic vein in the groove between the pectoralis major and deltoid, thus recognizing the upper edge of the pectoralis. Pass the finger around the pectoralis major one to two finger-breadths from the humerus. Guided by the finger, divide the pectoralis major.

FIG. 380.—Skin incision. (*Meyer.*)

Step 2.—The pectoralis minor now lies exposed to view. Divide this muscle near the coracoid process, and expose the great vessels and nerves of the axilla.

Step 3.—Beginning above, near the clavicle and coracoid process, dissect the fat from the axillary vessels and nerves, and then dissect it free towards the thoracic wall. By this means the most difficult step of the operation is completed while the surgeon is fresh, without the annoyance of the loose mass of mamma, etc., getting in the way, as in the Halstead operation, and while the chest is still protected against chill by its fatty coverings, which will be removed later.

Step 4.—Complete the incision around the breast (Fig. 378). Excise the

FIG. 381.—Insertion of pectoralis major muscle exposed. (*Meyer.*)
Operator's left index finger encircling its tendon.

FIG. 382.—Finger under tendon of pectoralis minor muscle. (*Meyer.*)
Above, cut surface of clavicular portion of pectoralis major parallel to clavicle is visible. (In the living, the belly of the pectoralis major is not so thoroughly detached from that of the pectoralis minor. It is done here to show the latter's tendon.)

mamma, surrounding fat, and both pectoral muscles. The wound left is large (Fig. 379).

Step 5.—After attending to hemostasis, close the wound, as much as possible, by sliding the flaps together. Where the wound cannot be closed, cover it with Thiersch's skin-grafts. Provide for axillary drainage by a tube introduced posteriorly.

After such extensive removal of important muscles one would naturally expect very serious loss of function, but such is not the case; the author has been

FIG. 383.—Subclavian and axillary veins fully exposed. (*Meyer.*)
So far, glands and fat tissue not removed; smaller vessels still in connection with main trunks. Finger under fat towards sulcus bicipitalis, its nail resting on axillary vein.

assured by various patients that they are able to attend to their own housework and to dress their own hair satisfactorily.

In the "Journ. Am. Med. Assoc.," July 29, 1905, Willy Meyer published an excellent series of drawings illustrating his operation; these are so helpful that they are reproduced here without comment (Figs. 380 to 385).

J. N. Jackson (Fig. 386), J. C. Warren and others have devised ingenious incisions for breast excision the only fault of some of these is that *perhaps* they may tempt the surgeon to sacrifice thoroughness of extirpation on the altar of æstheticism. The author has used Jackson's incision frequently with great satisfaction.

FIG. 384.—Operative field, after removal of the mass. (*Meyer.*)
Stump of pectoralis minor muscle is visible.

FIG. 385.—Showing reformation of axilla. (*Meyer.*)

In about 16 per cent. of cases of breast cancer, diffusion of the disease and perilymphangitis cause obstruction of the lymphatics about the shoulder and lead to œdema of the arm. The consequent suffering is often atrocious and amputation has often been performed to give relief. Handley's operation of lymphangioplasty is of value in treating such a condition.

Tansini's Operation.—(D'Este, "Rev. de Chir.," Feb., 1912). Stiles has shown that the breast is a much larger organ than is apparent on ordinary inspection and palpation (see Fig. 387). There is a constant prolongation of the breast upwards and outwards along the lower border of the pectoralis major which often reaches as far as the more anterior of the axillary lymphatic nodes (Rieffel, Poirier and Charpy, v, 680).

FIG. 386.—Jackson's incision.

Every modern operation for cancer of the breast aims at the excision of the skin over the breast along with the breast, the tissues around it which might be involved and the lymphatic contents of the axilla. In none of the operations already described (Halsted's, Meyer's, Kocher's, Jackson's) does the incision compel the removal of the skin overlying the axillary prolongation of the breast.

Tansini's method provides for very unusual and complete removal of the skin and for such convenient plastic repair of the wound that there is no temptation to skimp the extensive excision. The operation: *Step* 1.—Make the ovoid incision A B C D (Fig. 388) through the skin alone. This surrounds not merely the prominent mamma but the whole mammary region reaching medially (D) near or even onto the sternum, laterally (B) to the mid-axillary line, inferiorly (C) to the upper margin of the seventh rib and superiorly (A) to the summit of

the axilla. Note that all the skin between the breast and the axilla as well as most of the skin of the axilla itself is enclosed in the ovoid.

Step 2.—(a) Beginning at the lower external part of the ovoid (near B) dissect the skin from the subcutaneous fat until the whole infra-axillary region is exposed and the axillary border of the *latissimus dorsi* is reached. At this point penetrate more deeply so as to expose the *serratus magnus* above and the upper digitations of the *external oblique* below. (If necessary remove the fascia covering these muscles and some of their superficial fibres along with the mammary mass.) Passing upwards and inwards separate the inferior and lateral attachments of the pectoralis major from the thoracic wall. Attend to hemostasis.

(b) In similar fashion dissect the skin downwards and inwards from the ovoid incision until the desired limits for excision are reached. What are these

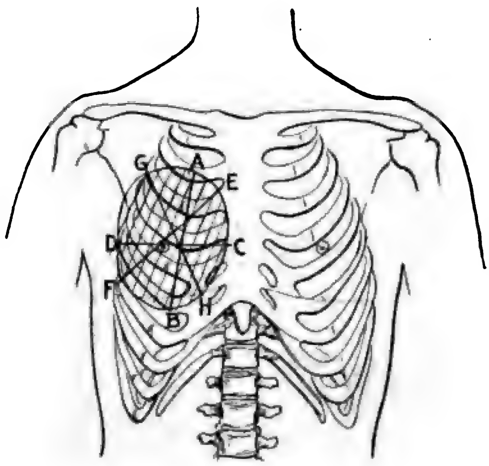


FIG. 387.

desired limits? From a very thorough study Sampson Handley (Cancer of the Breast and Its Operative Treatment, p. 183) has come to very definite and reasonable conclusions. He writes, "The removal of a maximal circular area of deep fascia centered upon the primary growth, is a step absolutely essential to the completeness of the operation, except in very early cases. There is no technical difficulty involved, if only the skin-flaps are sufficiently undermined, a step whose importance has been long emphasized by Mr. Stiles and by my friend and teacher, Mr. Jacobson, and one which is very thoroughly carried out in the surgical practice of the Middlesex Hospital. It is a significant fact that the operator, who has the best published operative results, lays stress on the removal of a wide area of deep fascia, following the lines laid down by Stiles. Prof. Cheyne says: "* * * the skin incisions when made should not go straight down to the muscle. After the skin incisions have been mapped out, the skin and just sufficient fat to enable it to retain its vitality should be dissected up, and the muscular fibres should not be exposed till just below the clavicle above, be-

yond the middle line in front, over the origin of the abdominal muscles below, and over the edge of the latissimus behind." It will be found that, judged by the standard I have set up—*i.e.*, the removal of a maximal area concentric with the growth—the area of deep fascia defined by Prof. Cheyne is very deficient in a downward direction, for the abdominal muscles arise well above the costal margin. The following measurements show the distance from the nipple to various points on the thorax in two patients with non-pendulous mammæ:

	Patient No. 1	Patient No. 2	Average
Nipple to tip of ensiform cartilage	4 in.	5 in.	4½ in.
Nipple to nearest point of clavicle	5 in.	6½ in.	5¾ in.
Nipple to nearest point of middle line	3½ in.	4½ in.	4 in.
Nipple to nearest point of edge of latissimus dorsi	....	5 in.	5 in.

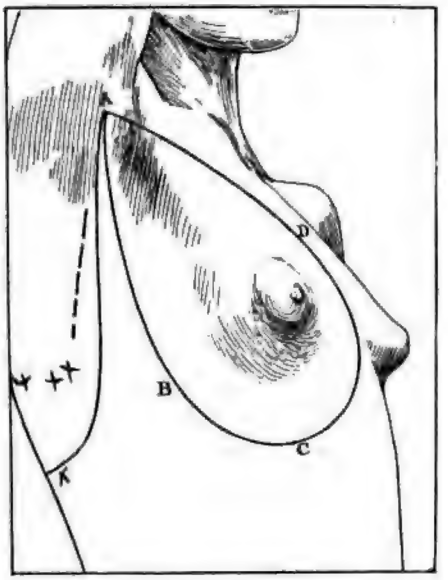


FIG. 388.

The distance from the nipple to the clavicle may be taken as the radius of the circle of deep fascia round the growth, which can, in practice, be removed without difficulty by undermining the skin flaps sufficiently and prolonging the incision somewhat in a downward direction.

If the growth starts under the nipple the deep fascia should accordingly be removed:

Above, up to the clavicle.
Internally, 1 to 2 inches beyond the middle line.
Externally, just beyond the anterior edge of the latissimus dorsi.
Below, to a horizontal line running 2 inches below the tip of the ensiform cartilage.

Coming now to growths situated near the margin of the breast, it is probable that the want of coincidence between the area of the present operation and the circle of infected fascia in these eccentric growths largely accounts for the bad prognosis associated with them.

The area of tissue removed should be concentric with the nipple only when the primary growth is situated just beneath that structure. If a cancer is situated at the sternal margin of the breast it may be necessary to excise the deep fascia beneath the inner half of the opposite breast. If the growth is situated at the lower margin of the breast it may be requisite to excise the abdominal deep fascia far down towards the umbilicus. If the growth is situated in the axillary tail of the mamma, the deep fascia will require excision in the deltoid region,

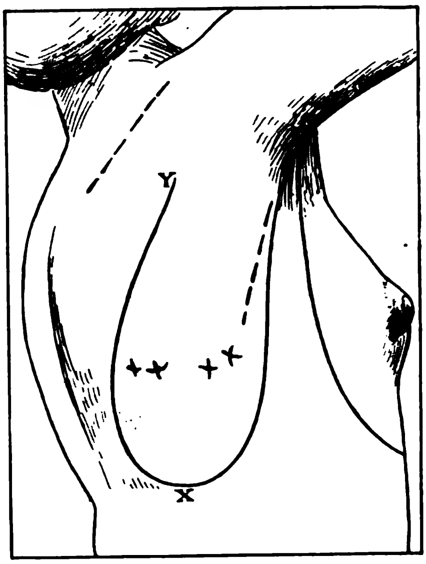


FIG. 389.

and far backwards over the surface of the latissimus dorsi. Unless these considerations are borne in mind the growing edge of fascial permeation will be left behind at one point or another.

(c) Dissect upwards and towards the axilla the whole mass of breast fascia, fat and muscle which must be removed. Both pectoralis major and minor must be removed though sometimes the clavicular fibers of the former may be spared.

(d) While the mobilized mass containing the breast, etc., is supported by an assistant, clear the axilla of its fat and lymphatic tissue in the usual fashion. In doing this ligate and divide the external mammary (long thoracic) and acromio-thoracic vessels, but save the subscapular vessels as they are essential to the nutrition of the flaps to be used in the plastic repair of the enormous denuded area of chest. Clear the fat from the infra-clavicular fossa. Along with the axillary fat remove the fat and cellular tissue lying between the scapula and the thoracic wall. Remember that all these tissues from the

interscapulo-thoracic space, the axilla, the infra-clavicular fossa and the chest wall ***must be removed in one piece.*** Attend to hemostasis. Cover the whole wound with warm dressings.

Step 3.—(a) Place the patient in the lateral posture or midway between the lateral and ventral postures. Have the arm held somewhat elevated and abducted. Recognize the spine, the axillary border and the inferior angle of

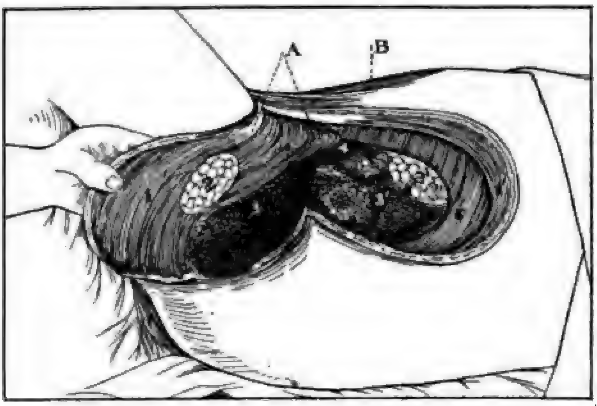


FIG. 390.

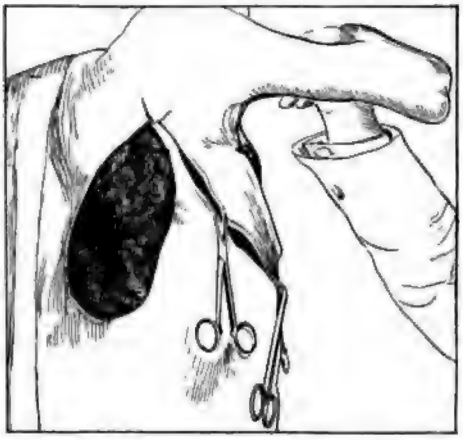


FIG. 391.

the scapula. Outline the flap A X Y (Figs. 389 and 390). The pedicle of the flap should be 7–8 cm. (2¾–3⅛ in.) in diameter. The incision penetrates the skin, the subcutaneous tissue and the latissimus dorsi (as soon as that muscle is encountered). Reflect the flap of skin, latissimus dorsi, teres major and a portion of the infra-spinatus. In separating these last two muscles from the scapula be careful to hug the bone, otherwise their nutrient arteries will be divided and disaster invited.

(b) Mobilize to some extent the tongue-shaped flap of skin lying between the dorsal flap and the thoracic wound. Bring the dorsal flap forward to cover the thoracic wound and suture it in position (Fig. 390). With the tongue-shaped flap fill up the dorsal wound. If any raw surfaces are left cover them with Thiersch's grafts.

J. N. Jackson in about 50 cases has had no skin recurrence. Handley points out that Halsted, who lays special stress on wide skin excision, has 16 per cent. of recurrence in the skin, while Cheyne, who removes more fascia than Halsted but less skin, has only 6.5 per cent. of such recurrence.

At the International Surgical Congress, 1908, Depage reported the following statistics collected from many sources:

	Primary mortality	Apparently well three years after operation
1865 to 1875	17.3 per cent.	9.4 per cent.
1875 to 1885	7.0 per cent.	10.0 per cent.
1885 to 1895	3.0 per cent.	34.8 per cent.
1895 to 1905	2.8 per cent.	46.5 per cent.

While in the decennium 1865 to 1875 among the recurrences 76 per cent. were local and 7.5 per cent. metastatic, in the period from 1895 to 1905 only 29 per cent. of the recurrences were local and 23 per cent. metastatic. The apparent increase in the number of metastatic recurrences is of course due to the absence of prompt local recurrence permitting the victims to live long enough to exhibit metastases.

CHAPTER XXXI

OPERATIONS ON THE CHEST

WOUNDS OF THE LUNGS AND PLEURÆ

Wounds of the lungs and pleuræ are commonly the result of stabs, bullet wounds, tearing by the fractured ends of ribs, and surgical operations. The dangers are hemorrhage, shock and pneumothorax. The shock is largely an incident of the pneumothorax; owing to pulmonary retraction due to pneumothorax, the heart and great vessels lose their normal support on one side, are displaced, often flop around and act in an inefficient fashion. The teaching of physiologists leaves the impression that the visceral and parietal pleuræ are kept in apposition entirely by atmospheric pressure; that puncture of the pleura inevitably produces pneumothorax and more or less complete retraction or collapse of the lung. This teaching has dominated surgery to too great an extent. Undoubtedly atmospheric pressure is a very great factor in retaining the normal apposition of the pleuræ but, as Macewen has shown, a large flap of the chest wall, including the parietal pleura, may be lifted up, exposing a corresponding surface of lung without pulmonary collapse. The failure of collapse is due to molecular adhesion between the two pleuræ aided by the existence between them of a thin layer of serous fluid, *i.e.*, the apposed surfaces of pleura are moist. If the finger is passed around the wound and separates the visceral from the parietal pleura air enters and a certain amount of collapse occurs, but if the elastic chest wall is pressed inwards so that the parietal pleura is allowed to come once more into free contact with the visceral, then the lung again expands. These remarks of course apply only to the healthy pleura, as in a pleura roughened by ridges and masses of exudates conditions are entirely different.

The above principles and observations of Macewen's were the basis of successful treatment in a number of serious wounds reported by him. ("Brit. Med. Journ." July 7, 1906.)

Elsberg ("Med. Record," May 23, 1908) finds that the weight of the heart pulls it backwards and makes tense the pleural covering of the anterior mediastinum when the patient is in the dorsal decubitus and thus predisposes to pneumothorax when the pleura is wounded. If the patient is placed in the ventral position pneumothorax is much less likely to arise. Lilienthal has applied Elsberg's findings with success in twenty-one cases in which the pleural cavity was opened and no interference with the mechanism of respiration resulted. Lilienthal's cases comprised a number of empyemas, two liver abscesses, five subphrenic abscesses and one left-sided bronchiectasis.

Methods of Keeping up Respiration when the Thorax is Freely Opened.—When one side of the thorax is freely opened respiration becomes much embarrassed

when both sides are freely opened it becomes impossible under ordinary circumstances. Matas and a number of others devised more or less complicated means by which air from a bellows, or its equivalent, could be pumped through the nose, the mouth or a tracheal cannula alternately into and out from the lungs ("Trans. Am. Surg. Assoc.," vol. xix). Richter ("Surg., Gyn., Obstet.," Nov., 1908) modified the pump method. In his apparatus the necessary air is stored in a tank under high pressure. As required, air is conducted from the tank to a rubber balloon where it can be kept at a moderate pressure. From the balloon the air is led through a rubber tube to a tracheal cannula and so into the lungs. An ingenious and simple electric valve permits air to flow into the lungs at proper and regulated intervals, and between these intervals permits it to escape. Another device permits the administration of an anesthetic. Richter demonstrated his method to the members of the Society of Clinical Surgery. Meltzer and Auer have described a method of artificial respiration which they name "respiration by the continuous intratracheal insufflation of air." A small tube is passed through the larynx into the trachea almost to the bifurcation, and by means of a foot-bellows or electric motor air mixed with ether is blown continuously through the tube under a pressure of 15 to 20 mm. of mercury. The lungs are kept moderately distended, the blood is aerated and the excess air escapes alongside the tube. The method has been used successfully by Carrel and Elsberg ("Annals Surg.," July, 1910) in many operations on the thoracic viscera. The author has used the Meltzer-Auer method in experimental work on rabbits, using instead of the foot-bellows a simple hydrostatic air compressor extemporized by Sutton. Elsberg suggests: "the tube that is to be introduced into the trachea should be a fairly rigid one of rubber with an opening at its lower end. It should be as long as an ordinary stomach-tube. Tubes of various sizes should be kept on hand. The tube to be used in a given case should fill up about one-half of the lumen of the trachea. One can obtain a sufficiently accurate idea of the size to be used by estimating the diameter of the trachea at the root of the neck." Lilienthal and Elsberg have applied the method successfully in the human being. To the author it appears that the continuous insufflation of air will probably become the method of choice for keeping up artificial respiration during intrathoracic operations.

Albert Ehrenfried ("Boston Med. and Surg. Journ.," April 13, 1911) endeavored to construct a simple, portable apparatus independent of electric currents, etc., by which ether might be administered according to the Meltzer-Auer method.

The apparatus (Fig. 392) "consists of a Wolff bottle with three necks, sitting within a copper water jacket, and a foot bellows. By means of cocks on the outside of the jacket, the stream of air from the bellows can be carried through the hot water, over the top of the ether (contained in the Wolff bottle), or through the ether when a particularly strong vapor is desired. Air and ether vapor may be mixed in any proportion. Connected with the delivery end of the apparatus is a safety valve and pressure regulator consisting of a bottle of mercury into which a tube is plunged. The depth of the tube in the mercury, which

is adjustable, represents the maximum of pressure which is allowed within the apparatus; if for any reason, such as a spasm of the glottis, the pressure should rise, the valve "blows off" automatically and danger from interstitial emphysema is avoided. In our early experience we employed a dial manometre, registering in millimetres of mercury, to record the pressure, but we have found that the pressure bottle answers as well for all practical purposes. The apparatus is provided with a device to prevent droplets of condensed ether being carried into the larynx. The air or mixture is supplied at a practically constant temperature of about ten degrees above room temperature; if the operation is to last over half or three-quarters of an hour, the contents of the water jacket should

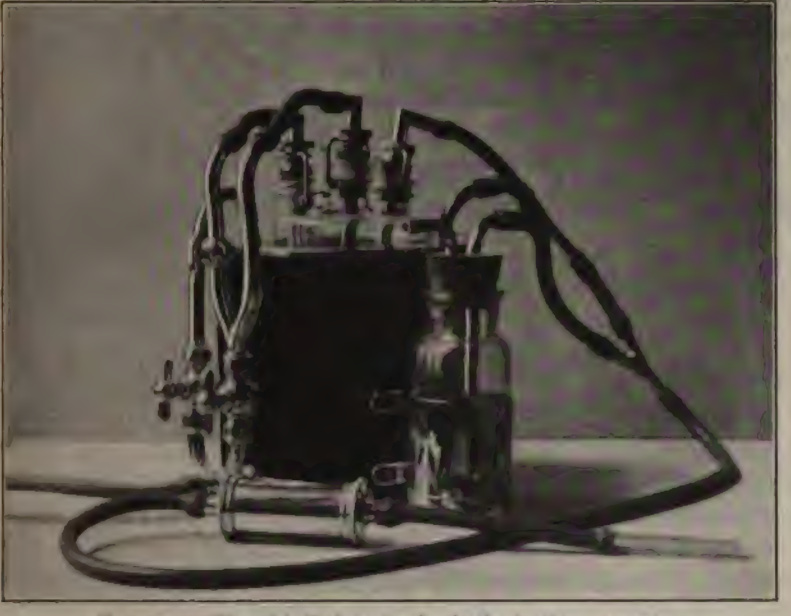


FIG. 392.—Ehrenfried's intratracheal etherization apparatus.

be replaced. The air supplied may be filtered and moistened. For an intratracheal tube we use a French lisle catheter, 22 to 24 F., moistened in hot water to render it pliable, a new and sterile one for each case. Soft rubber tubes have the advantage of standing sterilization by boiling better, but they are less easy to introduce. The chief difficulty with this method of anesthesia so far has been the introduction of the tube. We now use a simple introducer, a laryngeal forceps with sleeves attached for grasping the tube near its extremity, similar in principle to the introducer of Doyen. After considerable pains to produce the proper curve—working on frozen sections and cadavers—we have made an instrument, Fig. 393, which can be guided into the larynx in a matter of seconds, with the mouth gag in place and the left forefinger on the epiglottis, without the necessity of using a head mirror or electric illumination, or changing the

patient on the table to and from the Rose position, as is necessary with the direct laryngoscope."

Samuel Robinson ("Surg., Gyn., Obstet.," May, 1912) describes his apparatus by which ether may be administered by insufflation. He uses as the intratracheal tube a soft-rubber catheter introduced by means of Cotton's introducer. With the same apparatus positive pressure may be obtained by the mask method (Robinson's mask or Habberley's intrabuccal clamp). Robinson devised a positive and negative pressure cabinet, but finds cabinets cumbersome, expensive and possessing no advantage over the mask.

Danis ("La Presse Med.," Dec. 25, 1912) describes an hyper-pressure apparatus very similar to Robinson's which has been used successfully by Lambotte. The use of positive pressure by any mask method appeared to the author to be dangerous on account of vomiting, but Robinson remarks that "its temporary removal in case of such unusual emergencies as vomiting and instrumentation has not been found to interfere with its successful employment."

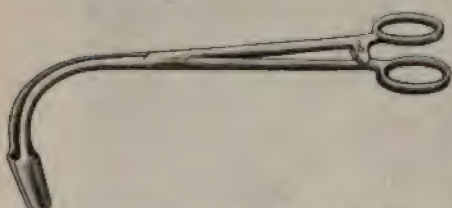


FIG. 393.—Ehrenfried's introducing forceps.

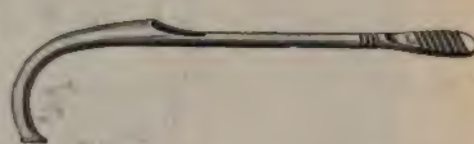


FIG. 394.—Ehrenfried's modification of Cotton-Boothly introducing cannula.

Sauerbruch was the first to devise a cabinet by means of which the thorax could be freely opened and respiration kept up under the force of either negative or positive pressure. Brauer constructed a rather clumsy apparatus for keeping up respiration under positive pressure. Willy Meyer and his brother (an engineer) have constructed a very efficient cabinet for both negative and positive pressures. It would be out of place to describe here the structure and methods for the employment of any of the pneumatic cabinets, each of which has its advantages and disadvantages; it will be sufficient to give the principles on which they work.

Negative Pressure Cabinet.—The surgeon, his assistants and the patient's body are inside the cabinet. The patient's head protrudes through a hole in the wall of the cabinet, his neck being surrounded by an air-tight collar. By means of an air pump, controlled by a manometre, the air pressure inside the cabinet is lowered sufficiently to permit of respiration after the thorax is opened.

Positive Pressure Cabinet.—Same as negative pressure cabinet except that the patient's body is outside while his head and the anesthetist are inside the cabinet. By means of an air pump the pressure of the air inside the cabinet is increased.

Artificial respiration by insufflation of air or by differential pressure apparatus must necessarily be of inestimable value in operations on the lungs, the chest

wall and the œsophagus. Carrel's researches show that probably surgery may in the future offer a cure for many of the diseases of the heart and great vessels. These researches were carried out on animals kept alive by the Meltzer-Auer air insufflation.

A. Treatment of Wounds Penetrating the Chest.—Do *not* let the patient lie on the healthy side. To do so directly interferes with the motion of that part of the chest; it also favors the entrance of air into the wound and conduces to separation of the two layers of the wounded pleura.

Exert steady pressure on the injured side of the chest, also, if necessary, on the hypochondrium of that side to support the diaphragm. If necessary administer a general anesthetic, but do *not* produce deep anesthesia.

Enlarge the wound sufficiently to permit exploration, removal of foreign materials, cleansing and hemostasis. If advisable remove a segment of one or more ribs. Steady pressure on the chest-wall may be sufficient to keep the pleuræ in apposition or to bring them into apposition if they have been separated by the trauma or during necessary exploration with finger or probe. If there is a wound of the lung, examine it, remove any foreign bodies, attend to hemostasis by means of pressure with hot pads of gauze, of ligatures or of catgut sutures. Close the pulmonary wound. Loosely pack the wound in the chest-wall with gauze and partly close the external wound. Apply dressings and immobilize the affected side of the chest with strapping applied tightly, as in the case of fractured ribs.

If pressure on the chest-wall fails to obtain and retain pleural contact it may possibly be a good plan to unite the wound in the lung to that in the chest-wall by a stitch.

The use of drainage by a loose pack is important, as otherwise effusions from the wound passing between the two pleural membranes might cause much trouble; the drain also permits air escaping from the pulmonary wound to pass out through the chest-wall.

Le Conte has had a large experience with penetrating wounds of the chest and finds the best means of stopping bleeding from the lung to be by the production of pneumothorax. Le Conte's views are so different from those usually propounded and his judgment is so good that it is well to reprint his conclusions.

"My conclusions are, then, that when the wound of the lung is giving only slight hemorrhage, close the external wound with gauze and watch for the physical signs of bleeding. When the hemorrhage is more marked, open the chest, insert a small drainage-tube, and regulate the admission of air according to the difficulty of respiration in the patient. When the hemorrhage is large and its symptoms alarming, open the chest and insert a large drainage-tube, so as to form a rapid and complete pneumothorax, and at the same time, when necessary, inject salt solution into a vein. When this does not control the hemorrhage, resect one or more ribs, and deal radically with the bleeding. In severe hemorrhage from a lung, the first object of treatment should be to get pressure on that lung. By opening the chest, air will do this as well as blood in the pleura; it will do it instantly instead of waiting until a sufficient amount of blood

has been poured out; it will save to the patient the amount of blood necessary to exert this mechanical pressure; it will permit the vessel to close by clots; and the remote benefits are that it eliminates the dangers of a pyothorax or of universal adhesions of the pleura. The danger from engorgement of the right side of the heart must be slight where the patient has lost much blood. Because it is a great danger in a full-blooded dog is no reason why it should be so in an exsanguined man, for the conditions are different and the cases not parallel. It is only fair for me to tell you that these views are my own, and are not indorsed by the majority of surgeons, but I give them to you because they are the result of my experience and because they seem to me logical and correct."

L. Clement ("Rev. de Chir.," Dec., 1911) is an advocate of non-intervention in most cases of injury to the lungs whether from gun-shot, stab or crushing lesions. He bases his opinion on a study of 53 cases in which there was no immediate operation but in some of which aspiration was practised once or repeatedly and in others (a small minority) pleurotomy was performed.

Clement writes: "if we study the clinical evolution of these pulmonary wounds we see them almost uniformly progress very favorably without any necessity for important or immediate intervention."

Among the 53 cases there were four deaths as follows:

1. Stab wound involving the aorta. Aortic wound temporarily obliterated. Fatal hemorrhage eight days later.

2. Gunshot wound of chest and abdomen. Severe hæmopneumothorax, multiple perforation of intestines.

3. Crushing injury. Semicomatose, intense dyspnœa, hemoptysis and hæmopneumothorax. After five days sudden death with symptoms of hemorrhage so severe as to leave no time for operation.

"All the other patients recovered after periods of from six days to three weeks or more and with a minimum of complications." There were only two cases of purulent pleurisy.

B. Treatment of Pneumothorax Resulting from Fracture of a Rib.—The indications for operative treatment are great respiratory distress and cyanosis with embarrassed heart action. The methods of treatment are two:

(*a*) *Aspiration.*—This gives immediate relief. If the wound in the lung closes and becomes sealed against the further escape of air, the relief is permanent. If the lung wound remains open, *e.g.*, from its size, from a shred of visceral pleura being pushed into it, etc., the symptoms will promptly recur and operation becomes urgent.

(*b*) Expose the fractured rib or ribs by incision (preferably vertical); excise enough of one or more ribs to gain access to the wound in the lung. Keep up pressure on the thoracic wall. An advantage of incomplete or of no anesthesia is that the patient may be made to cough, sneeze, struggle, etc., and so force the lung towards the wound. Treat the wound exactly as in the case of a stab wound.

C. Emphysema Resulting from a Fractured Rib.—The emphysema may or may not be accompanied by marked pneumothorax. Macewen (*loc. cit.*) has shown that the emphysema results from the lung tissue being hooked on to

the spiculæ at the fractured end of the rib and a free path being established between the injured lung and the lacerated subcutaneous tissues. Logically the operative treatment is identical with that for any other lung wound.

OPERATIONS ON THE PLEURAL CAVITY

Exploratory Puncture.—The existence of fluid in the pleural cavity is diagnosed or suspected; by exploratory puncture its presence and character are determined. Choose a point on the chest-wall corresponding to the location of the suspected fluid. Clean the skin thoroughly. Choose a hypodermic syringe with a long and not too fine needle and sterilize them. Insert the needle into the pleural cavity at a point just *above* a rib. This avoids danger of injuring the intercostal vessels. Slowly withdraw the piston of the syringe. If fluid is found, preserve it for examination; if it is not found, the operation should be repeated at several points and the needle examined after each withdrawal lest it should have become plugged. No dressings are required.

Thoracentesis.—The object of the operation is the removal of fluid from the pleural cavity. The operation may be: (*a*) *Exploratory.* The fluid withdrawn is examined microscopically. If tuberculosis is suspected, the examination should include the inoculation of guinea-pigs. (*b*) *Therapeutic.* In adults when the fluid is not infected the operation is curative. In children even when the fluid is infected a cure often results.

Strict asepsis must be maintained; otherwise a simple effusion into the pleural cavity may be converted into an empyema, or to the bacteria which have already produced an empyema there may be added others which may markedly increase the intensity and gravity of the disease. Dennis advocates surrounding with rubber sheets the area to be washed, so as to avoid chilling the patient unnecessarily with the antiseptic washes. The patient should be placed in a semi-erect posture, if necessary being propped up with pillows. If he is weak, give him a stimulant of strychnine or alcohol.

The favorite points for operation are the eighth intercostal space near the angle of the scapula and the sixth near the midaxillary line. Clean the patient's skin. If desired, inject a few drops of a 2 per cent. solution of cocaine into the skin at a point over the rib near its upper edge. With a fine knife make a puncture through the skin at this point. Pull the skin-wound upwards so that the needle of a Potain aspirator (thoroughly disinfected) can now be introduced and made to pass into the chest in contact or nearly so with the upper edge of the rib. The object of puncturing the skin with the knife is that, the skin being tough, so much force is required to push the aspirating needle through it that, the skin once passed, the needle is liable to be jerked into the tissues. Another reason is that disinfection of the deep layers of the skin being practically impossible, the needle cutting its way through may conceivably become infected and do harm.

In whatever way the skin is penetrated, the puncture through it should not be opposite that through the deep structures; a valvular wound is desired. The

needle is made to hug the upper edge of a rib so as to avoid injuring intercostal vessels. Having introduced the needle, aspiration is begun. If fluid does not come, this may be due to the needle having become clogged with tissue or a clot of fibrinous material. A stillette passed through the needle will free its lumen. If obstruction to the lumen is not the cause of failure to obtain fluid, the needle should be *partially* withdrawn and reintroduced in another direction. Working, as one does, in the dark, several punctures may be necessary before the fluid is found or one is satisfied that it is absent.

When the fluid flows, let it flow slowly. If the patient coughs or has a feeling of oppression, stop the flow until he recovers. The same must be done if the pulse alters markedly or the patient becomes faint. As the fluid escapes the patient may be lowered in his bed. If the effusion is great, it is wise to stop the operation before the fluid is nearly all removed. The remainder may be absorbed. The sudden, complete emptying of the sac is likely to do harm.

Morriston Davies (Lancet, Dec. 28, 1912; Brit. Med. Jr., April 25, 1914) finding it impossible to remove any appreciable quantity of pleuritic fluid especially in cases where its presence would interfere with skiagraphy of the lungs, has overcome all difficulties by replacing the abstracted fluid through the introduction of oxygen. He darws off the fluid by an aspirator in the usual manner but as soon as the first symptoms of drag on the intrathoracic organs are noticed, viz., discomfort, pain or cough, he permits about 100 c.c. of oxygen to flow into the chest through a needle introduced two or three interspaces above the aspirating needle. The two processes of aspiration and oxygen replacement are alternated until all the fluid is removed. The apparatus used for nitrogen pneumothorax acts admirably for the introduction of the oxygen.

Kenneth Mackenzie (Trans. Am. Surg. Assoc., 1914) uses warm sterile liquid paraffin instead of the oxygen. His technique seems unnecessarily elaborate but promises well. When it can be demonstrated that no more pus is forming the paraffin may be withdrawn very gradually—only two or four ounces being removed at a time at intervals of two or three days governed by X-ray examination until the pleura is free and occupied by a completely expanded lung.

Pleurisy Blocqueés.—Occasionally all the physical signs of fluid being in the pleura are present, the aspirating needle is inserted but no fluid flows. Examination of the needle shows no plugging of its lumen. Dufour, in 1905, showed that old pleuritic effusions exist which cannot be aspirated by ordinary means while Mosny and Stern ("La Presse Méd.," Dec. 11, 1909) demonstrated the same regarding certain recent acute pleurisies. The reason for the failure of aspiration is that the fluid happens to be in a cavity with rigid walls, *e.g.*, a cavity whose walls may consist of hepatized lung, the chest wall and pleuritic adhesions. If, as occasionally happens, the tension of the fluid is about equal to that of the atmosphere, then only a small amount of the fluid will escape through the aspirating needle; if the tension of the fluid is less than that of the atmosphere, no fluid will escape. If a second hollow needle is passed alongside the aspirating needle, atmospheric air will be admitted into the cavity and aspiration becomes easy.

Thoracotomy.—The objects to be attained by thoracotomy are:

I. Exploration and the performance of various operations by the transpleural route. For this purpose a long intercostal incision is excellent. Differential apparatus or intratracheal insufflation anesthesia is essential. Make a very long incision in an intercostal space down to but not through the pleura. Open the pleura in the same manner as the peritoneum is opened in laparotomy but even more carefully. At this point the anesthetist must arrange his apparatus so that the lung is *not* distended. After the pleura is opened it is well to use Carrel's technique (Trans. Am. Surg. Assoc., 1914, p. 452). "The operating field was walled off by two kinds of towels. The first kind was made of Japanese silk which had been previously boiled in water, dried, and sterilized in the autoclave, like ordinary pieces of dressing. The second kind of towel was composed of absorbent cotton and of black Japanese silk. These towels were made in the following way: Two pieces of fine black Japanese silk were sewed together at the edges. Between these two pieces was placed a layer of absorbent cotton about 1 cm. thick, and the whole towel was knotted throughout, thus forming a pad. These towels were sterilized in the autoclave. Both kinds of towel above described were used for walling off the operating field. When the ncision of the superficial part of the thoracic wall was completed and the hemostasis secured, the pleural cavity was opened by means of a small incision made n the middle of the intercostal space. A dry, white Japanese silk towel was ntroduced into one end of the incision, while a second one was introduced at the ther end. These towels afterward served as a protection to the anterior and osterior parts of the pleural cavity. Next, the incision of the thoracic wall was ompleted and the thoracic cavity was opened wide, the lungs being meanwhile ompletely protected by the towels already introduced. Immediately after is the black silk-and-cotton-padded towels were laid on the upper and lower ges of the wound and introduced into the cavity in such a manner that they pectively protected the upper and lower parts of the pleura. Next, a Gosset ractor was applied and the edges of the wound were retracted as much as was essary for the purpose of the operation. The edges of the padded towels e arranged in such a way as to circumscribe the operating field and to leave alone exposed to the air and to the sight of the operator. Additional led towels could be used afterward, if necessary, in order to secure a more plete walling off of the operating field. By means of this procedure the al cavity appeared to be almost completely protected against the infection ced by the atmospheric germs as well as against all possible infection or tion caused by the handling of the serous membrane by the hands of the tors, by the rough sponging with gauze, and by other operative trauma- Moreover, when hemorrhage occurred the blood was prevented from g into other parts of the thoracic cavity."

e Friedrich, Sauerbruch or de Quervain self-retaining retractors or rib rs serve well to open the wound widely. After completeing the operase the wound by interrupted buried sutures each of which surrounds the re and below the intercostal wound (pericostal sutures). As the last of

these sutures is being tied have the anesthetist cause the lung to expand so as to drive all air out of the pleural cavity.

In a case where no differential apparatus had been used Witzel filled the pleura with boracic acid solution and closed the wound. The condition was now one of hydrothorax instead of pneumothorax, and the fluid was easily removed by aspiration.

II. The second and infinitely the more common object of thoracotomy is to drain the pleural cavity. Local or general anesthesia may be employed, preferably local. Make an incision two inches in length parallel to the ribs at a point just anterior to the edge of the latissimus dorsi muscle and corresponding to the sixth, seventh, or eighth intercostal space. Along the lower border of the space cut through the intercostal muscles. Attend to hemostasis. Make a *small* opening through the parietal pleura. Too rapid evacuation of the pus is dangerous, as it too suddenly alters conditions of intrathoracic pressure. As the pus flows, enlarge the opening with forceps or the finger. Explore the empyema cavity with the finger and remove all shreds of tissue or clots of fibrin floating in the cavity. If such are left behind, they are liable to interfere with drainage and delay recovery. *Do not irrigate the cavity.* This has proved dangerous. Above all, do not use antiseptic irrigation. Drain by means of tubes passed into the pleural cavity. Not much of the tube should project into the pleura. The tubes may be rigid or soft. The writer generally uses a portion of a large soft-rubber catheter. To prevent the tube slipping into the pleura either stitch it to the skin or transfix it with a large safety-pin. If necessary (it rarely is necessary), partially close the skin-wound with sutures. Surround the outer end of the drain with sterile gauze in bird-nest fashion. This prevents direct pressure on the tube. Apply abundant dressings. Some surgeons place oiled silk over the mouth of the drainage-tube to act as a valve, allowing the escape but not the entrance of air into the pleura. This is unnecessary. After the pleura has been penetrated, a counteropening may seem desirable. To make this, pass a forceps through the wound, through the cavity, and with its point elevate the tissues at the position selected. Cut down on the forceps and push them through the new wound. Grasp a perforated rubber tube in the jaws of the forceps and pull the tube through the cavity. This provides efficient through-and-through drainage. Ochsner is a great advocate of through-and-through drainage. If at any time it is desired to withdraw the tube and introduce another, fasten a stout thread to the end of it and in withdrawing the tube pull the thread through the cavity; with this thread *in situ* it is easy to introduce another tube. Later the tube may be replaced by a few strands of silk-worm-gut. Tubular drainage must be kept up until all discharge has ceased. In cases of pneumococcic infection recovery is usually rapid, the lung expanding and obliterating the empyema cavity. When the infection is streptococcic, many weeks may elapse before the infected cavity becomes obliterated. Some surgeons to make drainage more perfect and continuous, connect the drainage-tube to a pipe passing through the dressings and attached to a Bunsen's air pump (Fig. 395). This ingenious measure is not often required. During the

after-treatment of cases of thoracotomy the patient should be placed in the position found at the operation to be most favorable for drainage. This position, especially if disagreeable, need not be kept up continuously, but adopted at intervals for a short time. It is wise to encourage the patient to sit up and move about at as early a date as possible. Fresh air is of great value in treatment.

Rutherford Morison thinks that an incision parallel to the ribs is likely to kink the tube (*a*) during respiratory movements, (*b*) from altered position after completion of operation. He operates as follows:

1. Verify presence of pus with hypodermic syringe.
2. Make a *vertical* incision down to rib and *across* intercostal space.
3. Push a sinus forceps (a closed, fine-pointed hemostat is satisfactory) into pleural cavity. Alongside the forceps introduce a director.
4. Open the forceps parallel to the ribs and pull them out while open, but leave the director *in situ*. (This method avoids hemorrhage.)
5. Guided by the director, introduce drainage-tube.

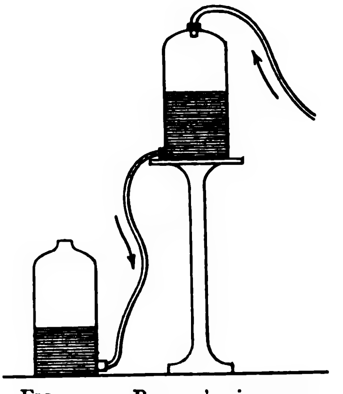


FIG. 395.—Bunsen's air pump.

Continue tubular drain until there is no more pus than can be accounted for by the external wound. After removal of tube introduce director daily so as to discover if pus reforms necessitating reintroduction of tube.

Thoracotomy with resection of a segment of rib is usually much preferable to simple intercostal incision. In the latter the space is limited, finger exploration is difficult or impossible, and when the tube is introduced, it is very liable to be pinched between the ribs and rendered useless. Removal of a segment of one or more ribs does no permanent harm and the operation is exceedingly easy. Excision of a segment of rib is rarely required in children and as rarely should it be omitted in adults. In operating on non-localized empyema the incision may be made over the sixth or seventh rib in the mid-axillary line, or over the ninth rib just external to the angle of the scapula, which is the best position. In cases of localized empyema the opening must of course be made over the encapsulated pus. When incision is made in the mid-axillary line, the patient must be brought to the edge of the table over which the affected side may protrude a little. When the posterior site of operation is chosen, place the patient, with the sound side uppermost, in a position midway between the lateral and ventral—*i.e.*, lying half over on his belly. *The sound side must never be undermost*, otherwise respiration will be impeded. The surgeon under these circumstances stands in front of the patient and reaches the site of the operation by leaning over him.

These are the classical instructions always insisted on but rarely carried out, except in trivial cases or by beginners who are much hampered by them. They are impracticable. In Friedrich's most extensive pneumolysis, the

patient lies on the sound side. The researches of Schäfer (Transactions, Section on Surg. and Anat., American Med. Assoc., 1908) on artificial respiration and the experiments and observations of Elsberg, clearly show that, *when possible*, the *prone* position is the position of choice for operations on the chest. Sauerbruch's cabinet might be of value but unfortunately it is still in a stage of development which places it beyond the reach of almost all surgeons. The other devices for carrying on respiration under positive or negative pressure (Brauer's Matas', Samuel Robinson's, Green's and Maury's, etc.) are not yet sufficiently simplified for common use. Richter's apparatus is most promising. ("Surg., Gyn., Obstet.," Nov., 1908.) The insufflation method of keeping up respiration is thoroughly practical but the necessary apparatus is by no means always available. Macewen's researches into the mechanism of respiration may lead to changes in methods of work. At present it is impossible to dogmatize regarding thoracic surgery.

The Operation.—1. Make an incision two to three inches in length along the long axis of the chosen rib and divide the periosteum along a line midway between the upper and lower borders of the rib.

2. With a curved periosteal elevator separate the periosteum from the bone both externally and internally. The intercostal vessels are separated from the bone with the periosteum. In recent cases much care must be exercised when detaching the periosteum from the deep surface of the bone lest the pleura be prematurely opened; in cases of long duration there is so much pleural thickening that no accident is likely to happen.

FIG. 396.—Rib shears.

3. Divide the exposed rib at the posterior end of the wound with bone forceps or rongeurs. For this purpose a costotome (Fig. 396) is convenient but not necessary. Grasp the portion of bone to be removed in the jaws of a sequestrum forceps, steady and bring it forwards, and divide it anteriorly with bone forceps. Two inches of bone should be removed.

4. Make a small incision through the deep layer of periosteum and the pleura. Let the pus flow out slowly. Interrupt its flow from time to time by plugging the wound with gauze. Too rapid evacuation means pulmonary congestion, and this is liable to cause fatal anæmia of the brain. Proceed as in thoracotomy. If the cavity is large, it is easy to resect portions of two

ribs subperiosteally through the same external incision. If this is done, the intercostal muscles and vessels should be ligated behind and in front of the pleural incisions and the two horizontal openings into the pleura united by a vertical cut to form an H-shaped wound (Fig. 397).

After thorough removal of clots of fibrin and necrosed tissue, Beck irrigates with salt solution, or if the pus is foul, with bichloride of mercury (1:5000). [Most surgeons condemn the irrigation.] If there is much shock or hemorrhage put off the evacuation of solid material and the use of irrigation for a day or two. Beck now stitches the costal pleura to the skin (pleurostomy) and packs the pus cavity with 3 per cent. iodoform gauze in the form of a long narrow strip with selvedged edges. The packing is done tightly for the first

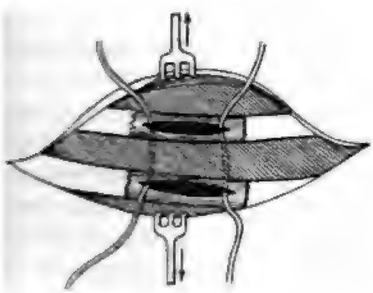


FIG. 397.—Thoracotomy.

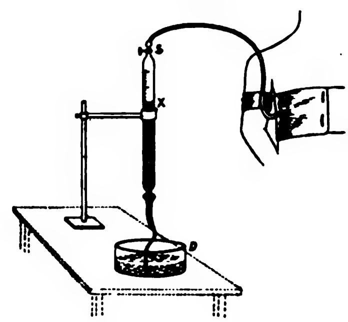


FIG. 398.—Perles' apparatus.

twenty-four hours in order to prevent hemorrhage, later on loosely. No subsequent irrigation is necessary. The packing after the first few days does not usually require to be changed oftener than every second or third day. Beck claims that the gauze soaking the pus into itself removes it from the pleural surfaces better than does a drainage-tube.

When the effects of an empyema are very menacing Lilienthal performs a simple thoracotomy under local anesthesia and introduces a drainage tube. When this simple operation has led to improvement he makes an incision, under local anæsthesia, usually along the seventh interspace from the angle of the rib to its costal cartilage. Before opening the pleura he administers nitrous oxide and oxygen and under that anesthetic opens the pleura freely—introduces a rib spreader which separates the seventh and eighth ribs for a width of several inches and gives a perfect view of the interior of the chest. Adhesions between the visceral and costal pleuræ must not be attacked but, with the finger, the lung ought to be separated from the diaphragm. In doing this it is not uncommon to open abscesses which would otherwise have been overlooked. Should the lung fail to expand, this failure is due to its being compressed and held down by organized exudates on its pleura. Lilienthal now follows Fowler and Delorme by incising the compressing membrane throughout the whole length of the lung and strips it off. The lung now expands. In closing the wound he sutures the divided latissimus dorsi and serratus magnus but not the intercostal muscles.

This method of Lilienthal's appeals to the author as being conservatively radical.

The cure of an empyema by drainage depends, first, on the free escape of the pus; and second, on expansion of the lung obliterating the pleural cavity and permitting the more or less complete adhesion of the parietal and visceral layers of the pleura. When the lung is unable to expand and approach the chest-wall, obliteration of the cavity may be obtained by bringing the chest wall to the lung. Ta accomplish this is the object of thoracoplasty. Before deciding for or against thoracoplasty it is of prime importance to know whether or not the lung is capable of expanding sufficiently to fill the thoracic cavity. For this purpose Perles' method of examination is good. (F. Karewski, "Die deutsche Klinik," viii, 313.) It is as follows:

I. Measure the capacity of the cavity by pouring into it an indifferent liquid from a vessel holding a known quantity. When the cavity is full, it is easy to calculate its capacity by noting the amount of liquid left in the vessel and subtracting it from the amount originally in it.

II. Measurement of the expansile power of the lung. The drainage-tube or cannula emerging from the empyema is connected by a tube to the graduated cylinder x (Fig. 398), at the top of which is a stopcock (s) and at the bottom a tube leading to a jar of water (d). The stopcock is closed and the cylinder and lower tube are full of water. Atmospheric pressure prevents the water leaving x as long as the stopcock remains closed. Open s, and at once the water in the cylinder x falls, aspirating air from the empyema cavity as long as the lung continues to expand. Whenever the water in the cylinder rises and falls with the patient's inspiration and expiration, it shows that the lung has approached the chest-wall as closely at it can. The amount of air now in the cylinder (x) can be read on the graduated scale, and represents how much the empyema cavity has been diminished by lung expansion.

Compare the results obtained by these two methods of examination. If the capacity of the cavity (known by Method I) is not very different from the expansile power of the lung (Method II), then it is wise not to proceed to thoracoplasty before trying some method of suction drainage. If there is a marked difference between the capacity of the cavity and the expansile power of the lung, thoracoplasty is proper.

Wilm's Operation for Empyema.—See p. 317.

Estlander's Operation.—Make a subperiosteal resection of three or four ribs (about 4 inches of each) through separate incisions, exactly as in thoracotomy with resection of rib. Instead of using separate skin-incisions the ribs may be exposed by a **U**, **T**-, **H**-, or **I**-shaped incision, the soft parts being reflected as a flap or flaps, and then the ribs resected subperiosteally. This operation permits a falling-in of the chest-wall, but in many cases the parietal pleura is so thick and hard that it is inelastic, and the desired retraction of the chest cannot take place. To obtain proper retraction the following procedure has been adopted:

Schede's Operation (*Thoracoplasty*).—Beginning at the origin of the pectoralis major at the level of the axilla make an incision which goes downwards

n a curve to the bottom of the pleural sac,—*i.e.*, the tenth rib in the posterior axillary line,—crosses the chest-wall from the front to the back, and ascends to the level of the second rib at a point between the spine and the scapula. Reflect upwards the huge flap thus outlined, and include in it *all* the tissues superficial to the ribs and intercostal muscles. Resect subperiosteally all the ribs over the cavity, from their tubercles to their insertion into the costal cartilages. To do this it is best to divide the rib at its middle with bone forceps, and, grasping the divided end of one of the fragments with sequestrum forceps, dissect it out of its periosteal bed. The other fragment is removed in the same fashion.

Bardenheuer has been compelled to excise even the first rib, the clavicle, and the scapula before he could obtain a satisfactory result.

Make a large incision through the thickened pleura to permit of thorough exploration. This exploration tells how many ribs must be excised and to what extent. Excise *all* the periosteum, intercostal muscles, and thickened pleura over the empyema cavity. There is not liable to be much hemorrhage from the intercostal vessels, owing to their being more or less obliterated by the disease, but the patients are usually debilitated, the operation is very severe, and hence it is necessary to clamp and ligate all the intercostal vessels. Hemostasis must be very carefully attended to. Some surgeons carefully scrape away all diseased granulation tissue, but all that is necessary is gentle wiping with gauze pads. Replace the flap of soft parts. This flap, at least if the disease has been extensive, will not by any means cover the defect, as its under or raw surface must be in contact with the outer surface of the retracted lung. Fasten the flap in position with sutures and properly applied gauze pads, so as to insure good contact between flap and lung. The remainder of the cavity must be filled with sterile (not iodoform) gauze and may subsequently be covered by Thiersch's skin-grafts or by flaps of skin. No poisonous antiseptics should be used during the operation, and the use of iodoform gauze is forbidden, owing to the great absorbing power of the tissues in question. Karewski finds vioform gauze as efficacious as iodoform, and perfectly safe as regards poisoning. Instead of replacing the reflected flap, Cheyne and Burchard recommend packing the whole cavity with gauze for a time, to permit of free drainage and of the formation of a layer of granulations on the deep surface of the flap.

As has been said, the operation is very severe, and the patients are always debilitated; hence it is often wise to refrain from completing the operation at one sitting, but to proceed step by step, *e.g.*, excising the ribs and indurated pleura from over the lower part of the empyema, and after this procedure has been recovered from, to advance higher.

The incision described is that of Schede, but an infinite variety of cuts have been advocated; as Kümmel (quoted by Karewski) says, almost ⅓ the letters of the alphabet have been imitated in forming incisions.

Delorme, Fowler, Beck, and others believe that the obstruction to oblitera-

tion of the empyema cavity is not so much the rigid chest-wall as the stiff, indurated, shrunken visceral pleura which imprisons and compresses the lung. These surgeons temporarily resect the thoracic wall, free the lung from its prison by "decortication," and close the chest. Jordan and Krause combine the method of decortication with Schede's operation. Most surgeons use decortication as an aid to incision of the thoracic wall, but discard the temporary resection.

Pulmonary Decortication.—George R. Fowler ("Med. News," June 15, 1901; "Am. Year-Book of Med. and Surg.," 1902) performed this operation in 1893 with very gratifying results. He writes: "An elliptical-shaped incision was made to include the orifice of the sinus, the soft parts cleared, and about 3½ inches each of the fifth and sixth ribs removed . . . . Commencing at the site of the opening in the chest-wall, the pleura was isolated by blunt dissection in the direction of the diaphragm until the latter was reached. It was then peeled off the latter until its limit towards the median line was reached, where it was found to rest against the displaced pericardium, from which, after much difficulty, it was finally detached. This dissection was greatly impeded by the movements of the diaphragm as well as those of the heart. The dissection was completed by lifting the mass and finally detaching it from the lung above. Considerable expansion of the lung followed at once, and in the course of twenty-eight days this was so far complete that the normal vesicular murmur was present to the level of the seventh rib. . . . Save for a slight sinking-in of the chest-wall at the site of the resection of the ribs there is nothing to suggest the previous existence of an empyema."

Fowler formulates the following conclusions:

"1. Decortication of the lung is an operation adapted to all cases of old empyema in which extensive and preoperatively discoverable tuberculous lesions of the lungs are not present, and in which the patient's condition will permit of a major operation.

"2. It may be advantageously substituted for Estlander's operation. . . .

"3. It should replace Schede's operation in all cases.

"4. The method by extirpation of the diseased portion of the pleural membrane, including the visceral, cortical, and diaphragmatic portions, is the operation of choice.

"5. Failing this, visceral pleurectomy should be selected.

"6. Pleurotomy, with simple detachment of the visceral layer of the diseased pleural membrane, gives sufficiently good results to warrant the surgeon in resorting to this procedure in cases in which the condition of the patient will not permit of the application of the other and more desirable methods.

"7. Whatever operative method is adopted, as complete access to the cavity of the chest as possible should be obtained, and rapid closure of the opening in the chest-wall afterwards secured, since the complete re-expansion of the lung must depend largely upon the normal respiratory movements.

"8. Pulmonary or respiratory exercises should not be neglected in the after-treatment. . . ."

Delorme in 1894 performed an operation very similar to that of Fowler ("Amer.

Year-Book of Med. and Surg.," 1902), and did it successfully under spinal cocainization. Out of twenty-nine cases of decortication by the Fowler method the functional results were eleven cured, six improved, nine unimproved, three died; as regards the cure of the empyema, seventeen were cured, nine unimproved, three died.

Delorme has devised a method of temporary resection of the chest-wall, by forming and reflecting a flap consisting of the *whole* chest-wall; this being done, he decorticates the lung, cleans the empyema cavity, and replaces the flap of chest-wall, providing of course for drainage. This operation has not found much favor.

Roux in operating finds that a long incision through the indurated visceral pleura answers the same purpose as decortication.

Kocher in his work on empyema is an opportunist; as the operation proceeds he finds out what has to be done and does it. If a fistula is present, he excises sufficient of one or two ribs in its location to permit of thorough exploration; if no fistula is present or if it is so situated that exploration from its site would be imperfect, he finds, by exploratory puncture, the lowest parts of the empyema, and there resects one or two ribs. Guided by the finger in the cavity he enlarges his original incision in the soft parts backwards and upwards between the spine and the scapula to the uttermost limits of the empyema. Step by step he divides the ribs and intercostal muscles in the line of the skin-incision. If the empyema extends to the first rib, then the first rib must be divided. From the anterior end of the original incision, guided by the necessities of the case, the wound is enlarged forwards and upwards and the corresponding portions of the ribs or costal cartilages divided. This flap, consisting of the whole thickness of the thoracic wall can be reflected upwards sufficiently to expose the position of the lung and the condition of the visceral pleura. If an incision through the visceral pleura demonstrates that the lung can expand, Kocher proceeds to pulmonary decortication until the lung expands sufficiently to fill the cavity. If the lung does not expand or does so only partially, he now proceeds to subperiosteal resection of the ribs, attacking them from the deep surface of the flap (Depage's method). To obtain proper mobility in the flap it may even be necessary to excise the first rib—no easy matter because of the subclavian vein. If the indurated costal pleura prevents the application of the flap to the shrunken lung, then the offending pleura must be excised. If, after incision and decortication of the visceral pleura, the lung expands sufficiently to obliterate the empyema cavity, Kocher follows Delorme in replacing the osteoplastic flap, but provides for drainage by excising a small segment of rib through a special incision.

The after-treatment of cases in which any of the methods of thoracoplasty has been used is prolonged; often a year or more elapses before a cure is obtained, and during this time several subsidiary and plastic operations may be necessary. One would naturally expect that ultimately great deformity, especially scoliosis, would be present, and that the lung deprived of its thoracic wall would be useless. This is, however, not the case. Wonderfully little deformity persists; the lung expands and becomes a useful organ. In many cases there is a very evident

reformation of ribs. As Karewski says, we must *not* be too sparing in removing large portions of ribs, especially in children, when this is demanded, as the lungs can still expand, and thus thoracic deformity may be avoided or reduced to a minimum.

Resection of the thoracic wall does not *per se* cause much deformity. The deformity depends on the amount of intrathoracic changes. It is not the removal of the chest-wall but the shrinking of its contents which is to blame (Th. Glück, Archiv für klin. Chir.," lxxxiii, 587).

When empyema affects both pleural cavities the following operations may be performed: (1) Double aspiration; (2) incision on one side, aspiration on the other; (3) incision on both sides; (4) resection and aspiration; (5) resection and incision; (6) resection on both sides (resection may include decortication). Hellin ("Berliner klin. Woch.," 1905, No. 45) recommends the operation of incision with drainage in double empyema; operation to be limited to one side at a time, and aspiration to be done one or two days prior to the incision. Local anesthesia is usually sufficient.

OPERATIVE TREATMENT OF PHTHISIS PULMONALIS

Excision of portions of the lung for tuberculosis has been of little or no value. The same is true regarding the treatment of phthisical cavities by means of aspiration and of injections. When nature cures tuberculosis she does so by converting the granulation tissue into mature scar tissue. If a phthisical cavity becomes obliterated, it is by the contraction of scar tissue, and this contraction causes a deformity or sinking in of the chest-wall.

Establishment of Artificial Pneumothorax.—In pulmonary tuberculosis if the visceral and parietal pleuræ are not too much adherent the lung may be collapsed and put at rest, temporarily, by filling the pleural cavity with some non-irritating gas which is not too readily absorbed. Carson in 1840 suggested the treatment but his work was forgotten until Forlanini and Murphy independently adopted the same idea and recommended the use of nitrogen. Brauer enthusiastically advocated the method. Nitrogen displacement is of special value in early progressive lesions, in cases where there is persistent fever, where there is profuse or repeated hemorrhage and where there is cavity formation in one lung.

The dangers incident to the operation are (*a*) shock. This is most noticeable in early cases and may be lessened by the careful use of local anesthesia; (*b*) embolism from puncture of a vein; (*c*) when the disease is very extensive, a comparatively small injection of gas may cause suffocation as the functional capacity of the lung is very small.

In cases where the pleura is widely and strongly adherent the pleural cavity is so obliterated that the operation is impossible; in other cases, where there are localized adhesions, introduction of gas may be of great value but it is difficult to place the point of the needle in the pleural cavity and to be sure that it is there. Brauer, under local anesthesia, makes an incision down to the pleura and inspects it. A transparent pleura with the lung surface moving to and fro beneath it

exposes a field in which it is easy to complete the injection without danger to the lung. Most operators discard the exploratory incision and content themselves with thoracentesis. It is wise to keep the patient quietly in bed for at least twenty-four hours and to give a hypodermic injection of morphine gr. 1/4 with atropine gr. 1/150, about half an hour before the operation.

The best site for puncturing the chest is somewhere in the anterior or mid-axillary line in the fifth, sixth, or seventh intercostal space. The patient is usually placed in a semi-recumbent position and turned slightly onto the sound side. Novocaine (not cocaine) is used as the local anesthetic and special attention must be given to anesthetizing the pleura. The proper use of a local anesthetic is of very great importance in preventing pleural reflex and shock. In very nervous patients suffering from early unilateral disease Woodcock and Clark (Brit. Med. J., Dec. 12, 1914) advise that, at the first sitting, after going through all the ritual of preparation nothing be done beyond injecting the local anesthetic. After four days the process is carried further and the nitrogen needle is pushed in until oscillation of the manometre shows that it is in the pleural cavity. At the third sitting a small amount of gas is introduced.

After the anesthetic has been injected, puncture the skin with a tenotome and introduce the nitrogen needle. Floyd's needle is good (Fig. 399). The puncture must be made slowly and deliberately until digital sense indicates that the correct depth has been reached when the trocar is to be withdrawn, the middle cock closed and the lateral opening connected with the manometre of Samuel Robinson's apparatus (Fig. 400). Before making this connection, isolate the manometre from the nitrogen circuit. If the needle is in the pleural cavity the negative intrathoracic pressure is indicated by the manometre and as this pressure varies with the respiratory movements so also does the manometre oscillate. "If the needle point is partly obstructed by contact with adhesions or lung tissue, this oscillation may not be more than 0.5 cm. Such a trifling oscillation is also found when the pleural space entered is one of small capacity on account of neighboring adhesions; but whether this oscillation be a complete or restricted one, its presence is an unerring guide that nitrogen may then be safely introduced. If the oscillation has been small, the amount of nitrogen injected is correspondingly low. A free oscillation of from 3 to 4 cm. is evidence of greater lung mobility, and the extent of the pneumothorax produced is correspondingly greater" (Robinson, Arch. Int. Med., IX, 467). The needle may require considerable manipulation or its site of insertion may require to be changed before the pleural cavity is safely penetrated. As soon as it is certain that the needle is in the pleura, close its connections with the manometre and open those with the nitrogen bottle and permit the nitrogen to flow slowly into the chest. The amount of nitrogen introduced varies with the case and with the ideas of the surgeon. Forlanini begins with a very small injection, Robinson with a larger. "If the nitrogen flow under moderate pressure is apparently unrestricted, 600 to 800 or even 1000 c.c. may be injected at the first operation" (Robinson). The feelings of the patient and any symptoms of distress, etc., which he may manifest must guide us frequently as to the amount of injection. Several injections at

intervals of a week or of several weeks may be necessary before a complete pneumothorax is established.

Morriston Davies writes (Brit. Med. J., April 25, 1914): "My experience is that the nitrogen is absorbed from the pleural cavity much more quickly during the earlier than during the later months of treatment, and it is essential therefore that the first few refills should be done at more frequent intervals than the subsequent ones. During the first six months of the treatment I run a fresh supply of nitrogen every six weeks, but after that I allow an interval of eight weeks to elapse. There is no necessity for the patient to be confined to bed at these times, but I make him lie down for three or four hours after the injection. Those who are at work are allowed to return to it the next day, and suffer little or no inconvenience from the increase in pressure. The amount of nitrogen required to replace that which has been absorbed varies from 500 to 1000 c.c. At the end of

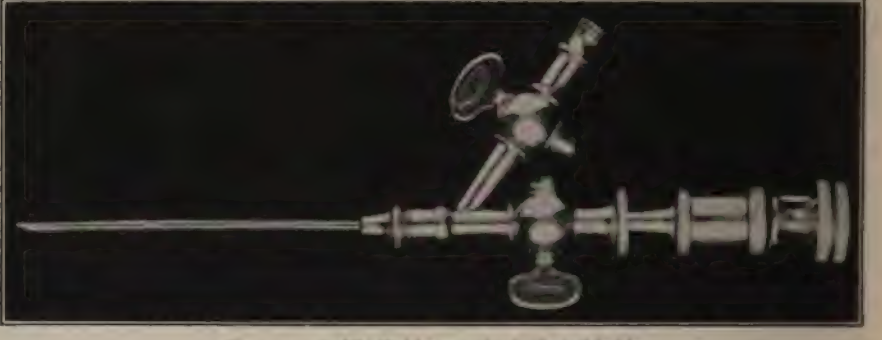


FIG. 399.—(*S. Robinson, Arch. Int. Med.*)

a year I allow the lung to re-expand so as to be able to make fresh clinical and radiographical observations, but as a rule it is advisable to maintain the displacement for at least eighteen months. If, during the earlier period of time, the lung is allowed to expand and the two pleural membranes to come into contact with each other, there is considerable risk that they will become adherent."

Figure 400, showing Robinson's apparatus, illustrates the principles employed in all forms of apparatus. Two bottles of 3500 c.c. capacity are employed. One is stationary and filled with water containing 2 drams of pyrogallic acid to take up any oxygen which may enter in conjunction with nitrogen. Nitrogen gas is then forced into the stationary bottle (*A*) displacing the water back to bottle *B*. At completion of this displacement the apparatus is ready for use. On opening certain cocks the water in bottle *B* replaces the nitrogen in bottle *A*, gradually filling it. The difference in the water levels of the two bottles represents the pressure under which the nitrogen is injected, the rapidity of its injection being regulated by the size of the opening in any one of the cocks. When bottle *B* is full, the maximum pressure is obtained, amounting to about 14 c.c. of water. As the water levels approach one another bottle *B* may be raised as in Fig. 400, thus maintaining the pressure until most of the nitrogen has been displaced, when the pressure is necessarily reduced. With

this hydrostatic mechanism the pressure may be varied at will, never attaining the dangerous limit. The arrangement of cocks *d*, *e*, and *f* corresponds to the substitution of a three-way cock at point *g*. In other words, with cock *d* closed and *e* and *f* open, a direct connection is established between the thoracic cavity and the manometre. With cock *f* closed and *c*, *d*, and *e* open, connection is made between the confined nitrogen and the manometre, thus recording the pressure represented by the difference in water levels of bottles *A* and *B*. With cock *e* closed and all others open the nitrogen passes directly from bottle *A* into the pleural cavity.

FIG. 400.—(*S. Robinson, Arch. Int. Med.*)

Numerous attempts have been made to permit atmospheric pressure to obliterate phthisical cavities by the resection of the bony chest-wall directly over the cavities. These attempts have failed because of insufficient sinking in of the chest-wall.

Friedrich (in conjunction with his colleague Brauer), recognizing the dangers of pneumothorax, and that adhesions between the lung and the chest-wall can easily prevent sufficient collapse of the lung when gases are put into the pleura, came to the conclusion that a very free removal of the rigid chest-wall without opening the pleura would be of value. This procedure he has carried out and

has named pneumolysis. The cases in which pneumolysis is justifiable must present the following conditions: (*a*) The disease must be mostly confined to one lung; the opposite lung can rarely be intact. (*b*) The disease *must be progressing* in spite of proper and thorough medical and climatic treatment. (Friedrich's cases were sent from sanatoriums where they had been under observation for several months or years.) (*c*) The general condition must be fair in order to withstand the severe operation.

In most of the cases operated on by Friedrich from 120 to 200 c.c. of sputum containing bacilli was expectorated in 24 hours, and fever was present up to the time of operation.

FIG. 401.—(*Friedrich.*)

Preparatory Treatment.—For three days administer digitalis hypodermatically. Attend to the bowels without weakening the patient. Give nutritious, easily digested food. In adults (not in the young) administer morphine an hour before operation.

The Operation.—*Anesthesia.*—In adults inject as much as 500 c.c. or more of Schleich's No. 2 solution but minus morphine and plus 8 drops of adrenalin to the 100 c.c. This injection is made along the line of incision and under the flap to be elevated. Most of the solution escapes during the operation. Sometimes Friedrich lightly freezes the skin along the line of incision with a spray of ethyl chloride. After the skin and muscle flap is reflected chloroform is administered.

In the young (under sixteen years) chloroform is used from the beginning in

von Braun's apparatus. In a case seen by the author only seven grams of chloroform sufficed.

Lay the patient on his sound side. Let an assistant hold the arm (well protected) and be ready to elevate it over the patient's head.

Step 1.—Make the huge U-shaped incision shown in Figs. 401 and 402. In the female the breast is avoided. (Fig. 403.)

Step 2.—Reflect the flap outlined. The flap contains skin, all the muscles down to the ribs, and the scapula. Obtain free access to every rib from the tenth up to and including the second.

Step 3.—If local anesthesia has been used, administer chloroform now.

FIG. 402.—(*Friedrich.*)

Step 4.—Beginning at the tenth rib proceed as follows: (*a*) Reflect the periosteum upwards and downwards from the whole external surface of the rib. (*b*) Near the middle of the rib separate the periosteum from the lower edge of the bone (for this purpose a nick with a knife is usually necessary before the elevator can pass under the rib). With gauze, finger and elevator carefully separate the periosteum plus the intercostal vessels from the groove under the rib. Complete the separation of the periosteum from the deep surface of the rib, and pass Friedrich's curved elevator completely around the rib. The curved elevator being round the rib, pull it (the elevator) with force back to or beyond the angle of the rib and forwards to the junction of the rib and costal cartilage. Divide the rib at its junction with the cartilage by means of a costotome. Seize the end of the rib and pull it outwards. Pass a finger along the visceral side of the rib to its head, to protect the pleura. Twist the rib

until it comes away. (Sometimes the head of the rib is torn from its connections; sometimes the neck of the bone is fractured.)

Step 5.—Repeat Step 4 on each rib until the second is removed.

Step 6.—With gauze and sharp dissection remove the intercostal muscles from the pleura. The twisting away of the ribs obliterates the intercostal arteries.

(Duration of operation up to end of Step 6 was twenty-five minutes in the case seen by the author.)

FIG. 403.—(*Friedrich.*)

Step 7.—Apply ligatures. Replace the flap and unite the divided muscles with catgut. Place a drain along the deep wound corresponding to the heads of the ribs. Close the skin wound. Apply abundant dressings. Operation on the right side is much more dangerous than on the left because of cardiac dislocation.

After-treatment.—Administer hypodermatically 1 c.c. camphor oil forty per cent. (40 per cent.) every hour by day and every two hours by night. Give digitalis freely. Each night inject 1½ L. salt solution in the inguinal region.

The salt solution has a most favorable influence on respiration. Administer oxygen frequently.

Of eight cases only two died and these had advanced secondary lesions elsewhere.

Of course, after recovery, medical and climatic treatment must be continued.

Figs. 403 and 404 show the extent of compensatory emphysema established in the sound lung and the great displacement of the heart.

In a few weeks the sputum has diminished from 150 or 200 c.c. to 20 or even

FIG. 404.—(*Friedrich.*)

5 c.c. and the patients have lost their fever and gained in weight. The operation is *sub judice* but seems to be of considerable promise.

Wilms' Operation.—(Wilms, "Muench. med. Woch.," 1911, No. 15; Kolb, "Muench. med. Woch.," 1911, No. 47.) In cases of unilateral chronic tuberculosis of the upper lobes of the lung and in total empyema Wilms endeavors to diminish the thoracic cavity by resecting 3–4 cm. of several ribs near their angles, supplemented when necessary by resection of the costal cartilages. The weight of the arm, among other factors, causes very great lessening of the

upper thoracic cavity after operation; the lower thorax is not so well obliterated, hence in empyema it may be necessary to excise completely some of the lower ribs in a secondary operation.

Wilms' operation like Friedrich's aims at pneumolysis and obliteration of the pleural cavity, while Freund's operation of chondrotomy aims at restoration or improvement of thoracic motion and at an increased thoracic cavity.

Use a local anesthetic (Wilms).

Step 1.—Make an incision parallel to the spine, over the angles of the ribs, from the first rib downwards as far as may be necessary. Reflect the skin so as to expose about 4 cm. of the subjacent muscles.

Step 2.—Split the fibres of the trapezius and rhombodeus muscles over the second rib. Retract the muscle vigorously so as to expose about 4 cm. of the first, second, and third ribs. Excise subperiosteally about 3–4 cm. of these ribs. In similar fashion split the muscles over the fifth rib and through that opening excise 3–4 cm. of the fourth, fifth and sixth ribs. Split the muscles over the seventh rib and excise through this opening portions from any of the lower ribs which prevent falling in of the chest wall.

Step 3.—Make an incision parallel to and 1–2 cm. from the edge of the sternum and excise the whole of the costal cartilages of the ribs which have been divided posteriorly.

Step 4.—Apply dressings held in place by adhesive straps firmly applied. Have the patient lie on the affected side.

Sauerbruch's operation is very similar to that of Wilms. The incision is made about 3 finger-breadths external to the vertebral spines, its lower end being extended outwards above the tenth rib. Through this incision the scapula is reflected outwards and portions of ribs are resected from the ninth and tenth upwards to and including the first. Of the lower ribs, 6 to 10 cm. of the upper 3 to 6 cm. should be removed. It is necessary to resect the ribs in the back close to the transverse processes of the corresponding vertebræ and it is important to resect small portions of the tenth or even of the eleventh rib since only in this way can the diaphragm be relaxed and also mobilized and the lung deprived of its inspiratory power (Henschen, Trans. Am. Surg. Assoc., 1914). Sauerbruch (Technik der Thoraxchirurgie) has also modified the Friedrich operation by operating in two stages. He first resects the ribs from the fourth or fifth to the eighth exactly as in Friedrich's method. After a few weeks he resects the remaining upper ribs as follows: Place the patient on his back with the shoulders slightly elevated. Abduct and elevate the arm as much as possible. Make a skin incision from without inwards along the clavicle. Continue its inner end downwards corresponding to the course of the internal mammary artery. Reflect the flap of skin and pectoralis outwards so as to expose the inner two-thirds of the upper ribs. Subperiosteally resect the *second* rib as extensively as possible—without injuring the pleura. This permits the apex of the lung to sink inwards away from the first rib. After raising the periosteum carefully and slowly, gnaw through the first rib with a narrow-bladed rongeur forceps, at the same time pushing the subclavian vein with the finger out of

harm's way. After dividing of the rib remove as much as possible of its median and lateral segments. Resect the third and fourth ribs. Replace the reflected flap and suture it.

Tuffier, Extrapleural Implantation of Fat.—*Lipotamponade.*—In cases of apical tuberculosis Tuffier operates as follows: Make a free incision through a suitable intercostal space down to but not through the parietal pleura. By blunt dissection separate the unopened pleura, corresponding to the apex, from the endothoracic fascia. Push the apex of the lung, covered by the pleura, downwards, thus creating a large extrapleural cavity. Fill this cavity with a free, *i.e.*, non-pedunculated mass of fat. Close the wound. Tuffier has found the operation useful and Wilms has had similar results. Instead of fat, Baer has used paraffin for the tamponade. Wilms thinks that in chronic phthisis with contraction the apical compression is insufficient; therefore he combines it with his own operation of rib resection in the lower thorax.

Ligation of Branches of the Pulmonary Artery.—When one of the principal branches of the pulmonary artery is tied there results induration and later contraction of the territory supplied, but without pneumonia. Sauerbruch has taken advantage of this in the treatment of bronchiectasis. To get the full benefit of this therapy it is necessary to complement it by subsequently mobilizing part of the chest-wall by means of a more or less limited resection of ribs. The arterial branches going to the left lower and right upper lobes of the lungs are specially suitable for ligation (Schumacher). To ligate the artery of the left lower lobe, place the patient on his right side with a pillow so placed as to make the left chest very prominent. Pull the left arm upwards and backwards. Make a long incision in the fifth intercostal space. Use differential-pressure apparatus or intratracheal insufflation. Be specially careful in opening the pleura because of the probable presence of adhesions. Separate the upper and lower lobes of the lung in the interlobar fissure and expose the pedicle of the lower lobe in which there lie the pulmonary artery and vein and the bronchus. The bronchus lies between the two vessels and the artery is the most superficial. Do not depend on pulsation in orientation as it is fallacious. Once the artery is found pass a ligature round it from the bronchus side. For one or two days after operation the breathing is shallow because of the pain.

Willy Meyer has experimentally ligated the pulmonary artery within the pericardium so as to avoid the difficulties of Sauerbruch's method when adhesions are present (Trans. Am. Surg. Assoc., 1913). Such operations are sometimes supplemented with unilateral section of the phrenic nerve in the neck whereby half the diaphragm is paralyzed and pushed up into the chest by the intra-abdominal pressure.

Exposure of the Phrenic Nerve in the Neck.—Make an incision along the posterior edge of the lower two-thirds of the sternomastoid muscle. Doubly ligate and divide the external jugular vein. Retract the sternomastoid forwards. Recognize the scalenus anticus muscle as it runs downwards to be inserted into the scalene tubercle on the first rib. Low down in front of this muscle is the subclavian vein; behind the muscle is the subclavian artery. The phrenic

nerve runs from above downwards and inwards obliquely on the anterior or superficial surface of the scalenus anticus and is somewhat overlapped by the internal jugular vein.

FREUND'S OPERATION FOR ALVEOLAR PULMONARY EMPHYSEMA AND APICAL PHTHISIS

In 1859 Freund demonstrated two important conditions of the thorax which were primary (direct or indirect) causes of pulmonary disease.

1. Impeded development of the first costal cartilage caused stenosis of the upper aperture of the thorax and this symmetrical or asymmetrical stenosis influenced the structure and function of the apex of the lung so as to render it susceptible to tuberculosis. If pseudarthrosis developed in this stenosed and immobile costal ring and permitted motion, then a natural cure of the apical tuberculosis supervened. For fifty years Freund urged operation to produce such pseudarthrosis and for fifty years his colleagues shook their heads to his pleadings.

2. Degeneration of the costal cartilages causing their enlargement and immobility in a position of inspiration (previously observed by Dupuytren) caused a widening of the lower thoracic opening and a flattening and atrophy of the diaphragm.

The resulting permanent dilatation of the thorax led to permanent distention of the lung, *i.e.*, to alveolar emphysema.

Freund formulated the following indications for operation: When stenosis of the upper aperture is demonstrated and there is repeated catarrhal trouble in the apex of the lung, operation is proper as a prophylactic measure; when under similar conditions an apical tuberculosis is present but does not extend below the second rib, then a curative operation is indicated.

An operation is indicated in the early stages or in fully developed alveolar emphysema before the occurrence of secondary affections with atrophy and great rarefication of the lung tissue and atrophy of the diaphragm, when rigid dilatation of the chest-wall is demonstrable. ("Archiv für klin. Chir.," xcii, 974.)

Von Hansemann ("Archiv für klin. Chir.," xcii, 993) considers Freund's operation very advisable in typical cases of apical phthisis where there is stenosis of the upper opening of the thorax and where the disease *does not extend lower* than the second or third rib.

Mohr emphasizes the fact that Freund's operation, in alveolar emphysema, is directed not against the pulmonary dilatation but against the dilated and rigid thorax which causes the emphysema. Operation must be followed by proper gymnastic exercises so that the muscles used in respiration receive proper education and training. Before deciding on operation it is important to study the condition of the heart, etc., lest relief of the thoracic rigidity might affect disastrously cardiac compensation. Mohr's experience with Freund's operation is considerable and he has been much impressed with its value.

ıd's suggestion has been carried out successfully by O. Hildebrand, ı and Haasler, Passler and Seidel, Goodman and Wachsmann, ı, etc.

value of Freund's operation was substantiated by the reports of many s at the German Surgical Congress of 1910.

operation may be done under local or general anesthesia. Cardiac ncy, asthma, chronic bronchitis and albuminuria according to Friedrich necessarily contraindications to operation.

Operation.

1.—Make the somewhat curved incision A B (Fig. 405). Expose and costal cartilages for 1½ to 2½ inches at their junction.

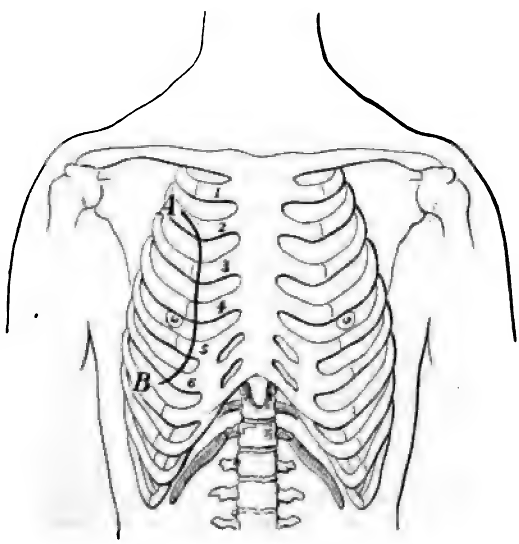


Fig. 405.—Freund's operation.

2.—Excise about 1½ to 2½ inches of the ribs and cartilages at their ı. This is done to the 2d, 3d, 4th, 5th, and 6th ribs.

n the operation is done for apical phthisis the first rib ought also to ved.

fully remove the periosteum and perichondrium corresponding to the portion of rib. This is done to prevent reformation of rib. Andrews tes the grove left by each cartilage with a circular stitch of catgut in prevent reformation of cartilage from fragments of perichondrium nay have excaped removal. He removes only segments of four ribs. ausen ("Zentralblatt für Chir.," May 14, 1910) notes the difficulty ing the periosteum and perichondrium left after removal of the ribs, gests overcoming this difficulty by applying the thermocautery to the ne instead of endeavoring to excise it.

urely theoretical grounds it seems to the author that it would be wise

to reflect a flap of periosteum, base outwards, from the anterior surface of the ribs, corresponding to the segment to be removed, and after removal of the segment of rib to carefully cover the cut end of the rib with the periosteal flap.

In one of Friedrich's cases (local anesthesia) the patient drew attention to the immediate relief obtained in his diaphragmatic respiration as soon as a rib was divided.

Henschen ("Archiv für klin. Chir.," xcvi, Hft. 4) considers Freund's chondrotomy the logical operation in cases of thoracic stenosis where the stenosis is due to ossification of the first costal cartilage and explains the location of apical tuberculosis in adults. This form of stenosis Henschen calls "Hart's anomaly of the aperture." It differs essentially from Freund's anomaly where a primary want of development of the cartilage, or of the rib itself, substitutes an antero-posterior oval for the normal transverse oval of the thoracic aperture, and where a flattening of the paravertebral portions of the rib causes subapical compression of the lung with all its ill effects. For this condition Henschen advises *paravertebral decompressive excision* of the first rib.

Henschen's Operation.—Place the patient in the semiprone position with the healthy side undermost. Put a pillow under the upper chest in such a manner that the arm (of the affected side) can be laid over it and strongly pulled outwards and downwards, the pillow acting as a fulcrum to the arm.

2. From the dorsal spine of the sixth and seventh cervical vertebræ make an incision through the skin outwards to the acromial end of the clavicle. At a point on this line 3 to 4 finger-breadths external to the spines of the vertebræ make an incision parallel to the vertebra and about 3 inches long. Part of this vertical cut is above and part below the horizontal incision. Reflect the skin flaps thus outlined.

3. Split the exposed portion of the trapezius in the line of the horizontal wound; divide the rhomboid and the superior serratus posticus; divide fully half of the levator anguli scapuli. With a retractor pull the upper angle of the scapula strongly downwards.

4. With the finger identify the tubercle of the first rib and bluntly isolate a segment of the rib for a distance of about 2–3 cm. outwards from the tubercle. Subperiosteally resect this segment of rib. If the second rib aids in producing the stenosis excise part of it also through the same wound. Apply a thermo-cautery to the periosteum to prevent reformation of bone.

5. Attend to hæmostasis. Close the wound. Dress.

Torek's Interpleural Pneumolysis (Surg., Gyn., Obst., July, 1914, p. 1).—When injections of nitrogen are unavailable beca useof the presence of adhesions, Torek endeavors to produce collapse of the lung without the dangers of the Friedrich operation. He operates as follows: Anesthesia by intratracheal insufflation. Trendelenburg's posture to prevent discharges, possibly expressed from the diseased lung, gravitating into the healthy lung.

Step 1.—Make a 6-inch incision through the 6th or 7th intercostal space at the postero-lateral aspect of the chest. Attend to hæmostasis before the pleura is incised.

Step 2.—Incise the parietal pleura. Separate the ribs with retarctors. Gently with the finger, and later with the whole hand, separate the adhesions between the visceral and parietal pleuræ. Some firm strands may require cutting. When the separation is completed the lung will collapse as much as the degree of its infiltration or consolidation permits.

If any superficial pulmonary cavities have been opened during the operation demonstrate their openings, if necessary, by having the anesthetist inflate the lung. Close any such openings by inversion sutures after the lung has collapsed again.

Step 3.—Close the pleural cavity without drainage. Close the chest by pericostal sutures. Close the skin wound.

As the air in the pleural cavity may become absorbed it may be necessary subsequently to fill the cavity with nitrogen gas.

OPERATIVE TREATMENT OF COSTAL TUBERCULOUS OSTEITIS AND OF THE RESULTING ABSCESSES

The most common and least efficacious treatment of the above affection is incision, thorough scraping with a sharp spoon, and iodoformization. This treatment is often insufficient, and when we remember that the excision of a segment of a rib is easy and harmless, then we can have little hesitation in adopting more radical and effectual methods.

Let it be assumed that we have to treat an unopened abscess, not adherent to the skin, originating from a tuberculous focus in a rib. Cheyne recommends an operation on the following lines: Make a vertical or oblique incision through the skin over the abscess. The incision ought to extend at either end beyond the abscess itself. Retract the edges of the wound and dissect back the skin from over the abscess until the whole swelling is freely exposed. Instead of the above, a curved incision may be used and a more or less U-shaped flap of skin elevated to expose the swelling. If possible, without rupturing the abscess, dissect it free from its surroundings except where it is attached to the offending rib. Expose the offending rib or ribs at each side of the abscess and subperiosteally divide them in such a manner that the whole mass, abscess cavity and rib, is removed *en masse*, leaving the posterior layer of periosteum *in situ*. On the normal cadaver this operation is difficult to do without puncturing the pleura, but in cases in which it is indicated, although caution must be exercised to avoid this accident, the accident is unlikely to happen, as the disease has caused thickening of the tissues. After removal of the abscess and segment of rib, examine carefully the remaining periosteum; if it is diseased, curette and swab it with liquid carbolic acid (neutralizing the acid by wiping with alcohol) or cautiously excise the diseased tissue. Attend to hemostasis and close the wound, after having provided for drainage. If it is impossible to excise the abscess intact, evacuate it either by incision and careful cleansing or by aspiration or puncture. If aspiration or puncture has been employed, close the puncture in the abscess wall with a

clamp or a purse-string suture before continuing the dissection. The same principles of treatment must be applied in cases of osseous disease with sinus formation.

When an infective disease, such as tuberculosis or typhoid, attacks one or more of the costal cartilages, repeated operations may be necessary before recovery takes place. Roux considered such cases almost incurable until he attacked them as follows: Through healthy tissue make an incision all around the focus of disease. Divide the skin, muscles, cartilage, and, if necessary, the bone. *When this cut has become sclerosed*, proceed to excise the disease. The wall of sclerotic tissue provided by the primary operation prevents spread of the disease in the now resistant cartilage ("Rev. de Chir.," Nov., 1904).

Axhausen ("Archiv für klin. Chir.," xcix, 219) after removing the disease covers the healthy stump of cartilage either with a pedunculated flap of muscle or by inverting the skin wound over the cartilage and suturing the skin to the tissues under the cartilage. The whole principle of treatment is to leave *no dead space* opposite the divided costal cartilage. Experience shows that covering the end of the cartilage with flaps of perichondrium does not fulfil the requirements. Costal cartilage transplanted to repair deformities in the nose and elsewhere, easily survives, but it is always in complete apposition with the surrounding tissues, *i.e.*, it does not abut on dead spaces.

EXCISION OF TUMORS OF THE CHEST-WALL AND OF THE PLEURA

Malignant tumors of the thoracic wall are seldom attacked unless—*e.g.*, in the course of an amputation of the breast—a tumor is accidentally found to be attached to the thorax, a state of affairs not known before the operation was begun. Parham has successfully removed a sarcoma of the chest-wall. Rixford ("Annals of Surg.," 1906, No. 1) has removed several carcinomata affecting the chest-wall. Deruginsky ("Annals of Surg.," 1906, No. 5) resected a portion of the chest-wall and the diaphragm for primary sarcoma of the pleura; the patient survived long enough to die from recurrence. Osteomata of the ribs ought, other things being favorable, always to be removed, because of the disastrous effects of their growth. The technique of the operation is very similar to that for the removal of tuberculous foci, and is along the following lines:

1. Make an incision all around the tumor, preserving as much skin as possible without cutting too near the disease.

2. Free the tumor from its surroundings, sacrificing all muscular tissue attached to it.

3. Subperiosteally divide all the ribs to which the tumor is adherent.

4. Note if the pleura is adherent to the tumor; if it is, then excise the adherent portions along with the tumor. Endeavor to avoid the *sudden* entrance of air into the pleura. Let the primary opening into the pleura be

small, so that the air enters slowly; with a moist pad of gauze close the opening at intervals so that the conditions of internal and external pressure may have time to adjust themselves. As the pleural wound is enlarged, progressively pack gauze (sterile) into the pleural cavity. The gauze packs shut off the rest of the cavity from the field of operation. Before the pleura is opened, warn the anesthetist to let the patient come out of deep anesthesia. Coughing on the part of the patient is now desirable, as the violent distention of the lung helps to guard against dangerous pneumothorax. When the packing of gauze has been thoroughly done, violent disturbances of respiration do not continue long. After the tumor has been removed, the gauze must be withdrawn and the lung, which is generally "coughed into" the wound, is caught and fixed to the thorax with a few stitches. This *pneumopexy* is of special importance when part of the lung demands removal.

When a segment of lung is affected by the tumor, it, of course, is adherent to it, and thus it is easy to apply sutures all around the diseased area. Dollinger advises that pneumothorax be *slowly* produced the day prior to operation. Delageniere, after taking similar precautions, has operated for two hours in the open thorax without ill effect. The safety of slowly produced pneumothorax is evidenced by J. B. Murphy's work on phthisis pulmonalis. One of the many methods of operating under differential pressure may be adopted with good effect. After removal of all the disease, even perhaps of part of the diaphragm, close the wound with sutures, providing efficient drainage.

If so much skin has been removed that complete closure is impossible, and if there has been no suturing of the lung to the thoracic wall (pneumopexy), part at least of the gauze packing must be left in place until adhesions form. In every case the dressings must be liberal, air-tight, and left undisturbed as long as possible. Emmet Rixford recommends closure of the wound, under the above circumstances, by means of a flap taken from the abdomen or from the chest-wall of the opposite side. The lung soon expands, and air left in the pleura rapidly disappears. (The preceding description of excision of tumors is largely taken from Karewski's admirable clinical lectures.) Rixford's paper on "Excision of Portions of the Chest-wall for Malignant Tumors" ("Annals of Surgery," Jan, 1906) substantiates in almost every particular the advice given above.

Pneumotomy.—Incision of the lung is demanded to provide for drainage in cases of pulmonary gangrene, abscess (whether tuberculous or pyogenic in origin), and large bronchiectatic cavities; also for the treatment of echinococcic cysts.

Operation is clearly indicated when the gangrenous area or the abscess is limited in extent, not multiple and is fairly accessible. It is usually considered improper to operate when the affected lung is widely diseased—*e.g.*, when there are large bronchiectatic cavities requiring drainage in both upper and lower lobes—but Th. Glück's experience shows that such may properly be attacked. The mortality of pulmonary gangrene treated non-surgically is 80 per cent.; treated surgically, 29 per cent. (McArthur).

G. Picot considers the mortality more than 75 per cent. without operation. When operation is performed early, some statistics show a mortality of but 17 per cent., but operation should only be undertaken where there is a single, circumscribed focus and the patient has good resisting power. Picot considers "radiography preceded by radioscopy" to be the most valuable method of diagnosis, as exploratory puncture is fallacious and dangerous, while ordinary clinical tests have led to innumerable errors in localization.

The abscess is carefully localized by the usual methods of physical diagnosis. During the first week of the existence of gangrene the X-ray will show a shadow, but after this time putrefaction leads to cavity formation and the rays show a light area. After cleaning the skin over the site of the lesion it is commonly advised to explore in the following manner: The long and delicate needle of an exploring syringe is pushed in the direction in which the pus is believed to exist. The needle ought to be attached to the syringe by means of rubber tubing which has been divided and reunited by the interposition of a small glass bulb or tube. When the point of the needle has penetrated the lung to the suspected area, slight suction is made with the syringe. If any pus is present, it will be noticed in the glass placed in the tubing. If no pus is found, make the needle penetrate more deeply and repeat the suction. After every change in the position of the needle make the suction test with the syringe. When the piston of the syringe has been pulled out to its full extent, clamp the rubber tube, detach the syringe, push the piston down, attach the syringe to the tube, remove the clamp, and proceed as before. It may be necessary to push the needle in various directions before the pus is found. Having found the abscess by the above means, leave the needle *in situ* and proceed to expose the abscess.

Most experienced surgeons are afraid of infecting the pleura if they use the exploring needle in the above manner. Expose the affected area by subperiosteally removing a segment of one or more ribs, palpate the uninjured pleura, noting if motion and friction are absent and if it is grayish-yellow in color or infiltrated (signs of adhesions). McArthur advises that a fine exploring needle be inserted for 1 cm. (3/8 inch) or less; if no adhesions are present the moving lung will cause the needle to rock; if adhesions are present the lung cannot slide on the parietal pleura, hence the needle will not rock. Note that this needle is *not* being used to explore for pus, but for adhesions. In the absence of adhesions it is advised *never* to use the needle to hunt for pus, because of the danger of infecting the pleura. If adhesions are present and palpation shows that solid—*i.e.*, diseased—lung is opposite the wound, either search for the pus with an aspirating needle (if pus is found leave the needle *in situ* until a free opening is made into the abscess) or at once penetrate the diseased area with a closed sinus forceps or with a Paquelin cautery heated to a dull red color. When the Paquelin cautery enters the cavity not only will pus flow, but smoke will be inhaled and exhaled. The principal advantage gained from the use of the cautery is that the walls of the channel made by it are sealed against absorption of the pus coming from the opened abscess. When the

cavity has been penetrated, pass in the finger, explore and open secondary cavities, gently remove with the finger and gauze loose sloughs and débris. Do not break down any bands felt traversing the cavity, such may be blood-vessels. Do not douche the cavity; douching is well calculated to spread infection to other parts of the lung or to drown the patient. Do *not* use peroxide of hydrogen, the explosive frothing of this drug has all the evils of the douche. Introduce a *loose* gauze pack. If iodoform is used in the gauze let it be in feeble quantity, as it is liable to be rapidly absorbed and cause poisoning. Instead of gauze a split rubber tube—preferably covered with gauze—may be used. The tube unless soft or protected may cause pressure, necrosis and hemorrhage. A cigarette drain is efficient and safe.

If when the pleura is exposed the adhesions do not appear so strong as to be above suspicion, reinforce them by a few catgut stitches uniting the parietal and visceral pleura around the operative area. A patient of L. L. McArthur seemed to be progressing favorably when he began to cough severely, ruptured the pleural adhesions, infected the healthy pleura and died from the infection. It is a good plan to expose the pleura (excising the necessary segments of rib and also of intercostal muscles) under local anesthesia. If the pleura is not adherent, the patient can easily force his lung into contact with the parietal pleura where it can readily be fixed by a few catgut sutures. A layer of gauze is now laid into the wound and the skin wound closed. After a few days the wound is reopened, the gauze removed and the pus sought.

Adhesions being present, "how shall we look for the diseased area in the lung if it is not immediately before us? Circumscribed gangrene in the lung is always surrounded by a zone of infiltrated inflammatory tissue—nature's barrier to the progress of the disease—so with the knife and finger we will explore any indurated area that may be present. If this fails to reveal the disease we will use the exploring or aspirating needle, and, by passing it in various directions in the lung, judge from the feeling imparted to the fingers the character of the tissue the point is traversing, and also from the discharges the needle may bring away. If this gives us negative results it is best to discontinue any further search, and complete the operation by leaving a drainage-tube in the incision in the lung. All hope of evacuating the septic material need not yet be abandoned, for several cases have been reported where the pus has found its way to the drainage-tube within a few days, and the patient has ultimately made a good recovery."

If, after subperiosteal resection of the ribs, the pleura is found to be non-adherent, adhesions must be provided, otherwise as soon as the pleural cavity is opened a dangerous condition of pneumothorax obtains. The formation of adhesions may be stimulated by the application of irritants, such as chloride of zinc, to the outer surface of the unopened parietal pleura. This is rather a blind method of reaching the goal. Most surgeons proceed somewhat as follows: A fully curved needle, armed with a thick silk or catgut suture, is passed through the *unopened* pleura, made to pick up as large a bite of the lung and visceral pleura as is possible, and brought out again through

the parietal pleura. Much gentleness must be exercised in tying the sutures as the pulmonary tissue is friable. From two to four sutures will generally be found ample to secure apposition of the two pleural layers. The parietal pleura is weak, therefore the sutures should catch other tissues as well. The sutures may be made to penetrate a large gauze pad (four thicknesses) laid on the outside of the chest, with an opening in the centre to permit of subsequent operation. The subsequent steps of the operation should be carried out, in the manner already described, after the lapse of a week.

Should the case be one of such urgency as to warrant incurring the extra risk, one must surround the diseased area by a row of interrupted "back-stitch" or interlocking sutures of catgut, uniting the parietes to the visceral pleura and lung. Do not take too deep a "bite" of lung with the needle. If pleural suturing is, from any cause, impossible, pack the pleural cavity as it is opened with gauze, as in the case of empyema; a smaller amount of gauze may suffice if the gauze packing is sutured with catgut into the pleural opening. It has been claimed that aseptic silk sutures applied to the non-infected pleura do not produce enough irritation to ensure the formation of effective adhesions. Silk sutures soaked in turpentine have been employed and found to be satisfactory.

After the pus or the contents of the echinococcic cysts have been evacuated, provision must be made for drainage. This is best done by leaving the wound wide open and packing with sterile gauze (iodoform gauze is liable to lead to poisoning). Rubber tubes may be used *if surrounded by gauze.* Tubes unprotected by gauze occasionally cause erosion of blood-vessels. When there is much loss of lung substance and there is not sufficient compensatory distention of the remainder to fill the resulting void in the thorax, the treatment must be similar to that of old empyema, viz., resection of an appropriate amount of thoracic wall. Lung wounds heal slowly and form but few granulations. Epidermization progresses from the skin alone; any growth of epithelium from divided bronchi leads to persistent fistulæ being formed. As soon as retraction or dragging inwards of the external soft parts ceases to progress satisfactorily, recovery may be hastened by the use of skin-flaps obtained in the neighborhood. If bronchial fistulæ persist, they may be closed by the application of the cautery. It must be remembered, however, that a persistent bronchial fistula may be, in reality, beneficial in that it gives vent to discharges which would otherwise be retained and cause serious trouble.

Pneumectomy.—Th. Glück, as early as 1882, elaborated the following method of excising one lung or part thereof. After opening the thorax by the removal of a segment from one or more ribs, grasp the lung with a clamp and pull a cone of it through the opening in the thorax. Apply a ligature behind the clamp, pull more of the lung through the wound and apply another clamp. Repeat this process of pulling the lung outwards with a clamp and ligating until the desired amount of lung is herniated or until the pulmonary root is reached. Cut away the lung distal to the last ligature, leaving about one inch of lung tis-

sue protruding from the ligature. Suture the cut surface of the stump with interlocking stitches of catgut.

Glück ("Archiv für klin. Chir.," lxxxiii, 592) reports the following two cases on which he operated using the clamp and ligature method.

R. P., thirteen years, March 3, 1899. Multiple, fetid bronchiectasis of left lung. Resection of the sixth to tenth ribs. Resection of the upper lobe and total pneumectomy of the lower lobe of the left lung. Before operation an enormous amount of gangrenous material was discharged each day, after operation the discharge was not worth noticing and had no bad smell. The patient felt well, ran about and played with other children. In October, 1899, the thoracic wound was not completely healed; an operation was undertaken to close the wound and the patient died from unexpected collapse and heart failure (Herztod). Autopsy showed chronic interstitial and parenchymatous myocarditis. The bronchiectatic process had been completely removed and the lung wound had healed. Heidenhain has resected the lower lobe (left) of a lung—the seat of bronchiectatic cavities—with success.

Glück's second case is most important. The patient suffered in 1896 from lymphangitis migrans and thrombo-phlebitis of the left and subsequently of the right lower extremities. In May, 1897, there were left-sided pulmonary infarcts; the left pleura was twice punctured and large amounts of exudates removed. Recovery in July, 1897. In April, 1899, septic phlegmon extensor aspect of right forearm, which was nearly healed in July, when there was a chill with 41.5° [illegible] of fever. Pyemia developed requiring radical operation for right axillary abscess and phlegmon of chest-wall (twice); evacuation abscess on sternum; transverse drainage, right ankle-joint; operation, left pleural empyema (twice). In spite of extensive resection of ribs and evacuation of pus from the pleura elastic fibres were found in the putrid discharges. January [illegible] there were bloody sputum, dyspnœa and extreme weakness. The thorax was opened widely, the enormously thickened and degenerated pleura was resected and the whole lower lobe of the left lung was removed with the aid of clamps and ligatures. During the after-treatment the patient could breathe freely and comfortably through the wound when his mouth and nose were closed. Healing was completed in nine months. Nine years after operation the scar is on a level with the skin: and in spite of the extensive resection of ribs there is neither deformity of the thorax nor spine. The diaphragm has formed upwards and the upper lobe of the lung was vicariously expanded. In pneumectomy closure of the divided bronchi is always a difficulty. Willy Meyer has overcome this difficulty by separating the peribronchial vessels from the bronchi and ligating them, then by crushing the stiff bronchi with an angiotribe he is able to treat it by ligature and inversion sutures like the stump in appendectomy.

Remarks on Pulmonary Surgery.—In [illegible] by no means always necessary to use some form of differential [illegible] tracheal insufflation [illegible] it is well to have [illegible] sion of the lung by nitrogen gas in the pleura [illegible]

phthisis, especially in early cases. Depage suggests that this treatment may be valuable in unilateral pneumonia with very acute intoxication. Compression of the lung by means of extrapleural fat, by paraffin tamponade, or by some form of thoracoplasty is valuable in some severe cases of phthisis and may give improvement but not cure, in bronchiectasis. Such lung compression will probably form a step preliminary to pneumectomy in bronchiectasis.

Sauerbruch's ligation of the pulmonary artery is probably valuable along the same lines as is permanent compression. The surgery of the lung is not yet on any sure foundation. (See discussion on Thoracic Surgery. Trans. Am. Surg. Assoc., 1914, and Annals of Surg., lix and lx. Fred T. Murphy; Lilienthal; DePage; Scudder; Henschen; Willy Meyer; Mumford and others.)

EXPOSURE OF THE PERICARDIUM AND OF THE HEART

Operations on the Orifices of the Heart.—The investigations of Carrel and his disciples have achieved so much that no great boldness is required to prophecy that the surgeon will, before long, aid in the therapeutics of certain lesions of the cardiac orifices. The following paragraphs are based on the publications of Carrel and Tuffier (Annals Surg., July, 1914; La Presse Med. 4, March, 1914). The lesions which ought to be susceptible to surgical aid are:

1. Mitral stenoses. In these the *free borders* of the valves are alone affected, the valves themselves, the cardiac muscle and the peripheral circulation remaining for a long time in good condition.

2. Aortic stenoses may occupy three positions, viz., valvular, supra-aortic and infra-aortic; of these only the valvular are likely to be amenable to surgical intervention. Valvular lesions are characterized by adhesions, thickenings and deformations of the borders of the valves, forming a simple indurated ring. Exceptionally the lesion affects the fibrous circle at the base of the valves.

3. Stenoses of the pulmonary artery are similar to those of the aorta, but the artery itself is dilated *above* the stenosis, this being due to a loss of elasticity in its walls.

4. Congenital tricuspid stenoses show similar characteristics and are peculiarly suited to operative treatment because of the integrity of the heart.

Although an orificial lesion is anatomically suitable for operation, and although the cardiac muscle and vessels are sufficiently healthy to give hope of success, yet operation is not justifiable unless the disease by its persistence and progressiveness inevitably will early give rise to grave or mortal troubles. Such indications for operative treatment are rare.

A pure mitral stenosis in a young subject with a healthy heart, in which the trouble is progressive as shown by functional symptoms, and which will certainly be fatal, is a proper case for operation. Some slowly advancing aortic stenoses with hypertrophy of the left ventricle may also be considered mechanical lesions susceptible of treatment by enlargement of the orifice.

Stenoses of the pulmonary artery when isolated and independent of any other cardiac malformation are almost always soon fatal from pulmonary tuberculosis.

it is not likely that lesions causing insufficiency of the cardiac orifices will be suitable for operation.

Special Dangers in Cardiac Operations.—(*a*) Injury to the coronary vessels. The coronary vein may be tied with impunity but *not* near its main trunk.

Injuries to the peripheral parts of the coronary arteries are well borne. Near the origin of the arteries even a prick with the finest needle gives rise to serious symptoms. Ligation of the artery proximal to its bifurcation is always promptly fatal.

(*b*) The only bleeding which is difficult to arrest is that from the left auricle. This is due to the thinness and friability of its walls.

(*c*) The entry of air into the right ventricle with consequent pulmonary "air embolism" is not of the gravest moment, but its entry into the left ventricle leads to fatal embolism in the coronary arteries. Air in the heart is removed by aspiration.

(*d*) The danger zones of the heart are:

1. The coronary vessels between their origin and their first divisions must not be touched.

2. The inter-auricular septum is so sensitive that the least injury to it causes arrest of the heart in diastole.

3. Section of the auriculo-ventricular septum causes immediate arrest of the left ventricle in diastole. In the auriculo-ventricular region near the left border of the heart there is a sort of vital node, injury to which is dangerous or mortal, even a slight pressure here excites an extrasystole.

4. At the junction of the middle and upper thirds of the anterior longitudinal groove there is a point at which mechanical irritation can cause sudden arrest of the heart.

5. The motor stimulus of the heart originates at the base of the right auricle near the venous orifices. This is a very dangerous zone.

For cardiac operations, anesthesia is produced with ether given by the Meltzer-Auer method. The thoracic cavity is opened, the operative field is walled off with "oil silk and cotton knotted compresses," the pericardium is opened and the heart is exposed. A Doyen forceps (jaws protected by rubber tubing) is used to compress the pedicle of the heart. The heart is not dislocated but the pericardial wound must be large enough to give free access. One blade of the clamp is introduced into the pericardium under the pedicle and directed from the right to the left side by the finger. At this moment (without any compression) over-ventilate the blood by the Meltzer-Auer method and then rapidly close the clamp and without a moment's delay proceed with the operation. The pedicle may be clamped for two and a half ($2\frac{1}{2}$) or three (3) minutes with safety.

Exposure of the Aortic and Pulmonary Orifices.—For the pulmonary orifice make the incision on the left side of the artery at the junction of the anterior and left sigmoid valves. The incision is made by means of scissors of unequal blades, the longer blade being pointed. With this the vessel is punctured before the cut is made. Exposure may be effected by a cut in the artery alone; usually

in experiments the incision was about 4 cm. long, half of which was on the pulmonary artery and half on the ventricle. Here the branches of the coronary artery are small and can be cut without danger.

For the aortic valves make the incision on the right side of the aorta between the mouths of the right and left coronary arteries, generally directly above the middle of the right valve.

When the operation has been completed, suture the wound with a continuous suture of No. 1 Chinese silk sterilized in vaseline. Introduce through the line of suture a curved cannula connected with an aspirator and suck out the air from the heart. Remove the pedicle clamp.

What operations may be performed on the valves? Carrel has cauterized the valves and has dilated the orifices with the finger. Tuffier performed this operation on a patient with amelioration of symptoms. Sir Lauder Brunton, Harvey Cushing and others have divided valves by special long delicate tenotome-like instruments introduced at a distance. Tuffier remarks: "if one divides the valvular diaphragm without resecting a portion of it, it is necessary to fix one of the lateral valves to the ventricular wall with a silk suture in order to prevent coalescence and secondary reunion of their borders." Such operations may be named internal valvulotomy. External valvulotomy with patching of the vessel is being done very successfully in animals without clamping the pedicle of the heart.

Carrel thus describes the operation: "A piece of vena cava or of any other vein, preserved in cold storage, was cut into the shape of a rectangular flap about 2.5 by 2 cm. This flap was put on the anterior part of the pulmonary artery in such a way that its middle corresponded about to the pulmonary orifice, the lower part being on the surface of the ventricular wall. Then the two lateral sides and the upper side were fixed to the surface of the heart and the pulmonary artery by means of a continuous suture. The longer blade of the scissors was introduced underneath the lower side of the flap and the sharp point was introduced into the lumen of the pulmonary orifice. Then the wall was cut and dark blood escaped between the surface of the heart and the lower part of the flap, but the hemorrhage was immediately controlled by the index-finger of the operator which compressed the flap down on the wound. The fourth side of the flap was next fixed to the surface of the heart by a continuous suture. The flap immediately appeared distended by dark blood, and it was assumed that in case of stenosis of the pulmonary orifice this operation would permit of a dilatation of that orifice. The operation was performed without stopping the circulation of the heart. The operation would be rendered easier by clamping the pedicle of the heart for a very short time. Although this is a more dangerous procedure, it is probable that it would simplify the operation." In their experiments on dogs Carrel and Tuffier opened the thorax by an incision from the sternum (internal mammary vessels ligated and divided) to the posterior part of the axilla, in the second or third intercostal space. The second space was chosen when access to the great vessels was desired.

It is not necessary to resect any ribs. The pleura is incised and the ribs

separated by a mechanical self-retaining retractor. Once pneumothorax is established respiration by means of the Meltzer-Auer apparatus is easy. The pleura is protected by compresses of fine vaselinized silk.

H. M. W. Gray (Birkbeck and Lorimer, Brit. Med. J., Oct., 1915) has removed a bullet from the cavity of the right ventricle. The patient died four days after operation from multiple pulmonary infarction. The operation was performed under morphine and local anæsthesia (eucaine 1 per cent; potassium sulph. ¼ per cent; adrenalin). The pericardium was widely exposed by reflecting a large flap of sternum and costal cartilages. The right pleura was opened and the lung collapsed causing respiratory trouble and anxiety for about one minute. The pericardium was freely opened. During palpation of the heart a beat was missed occasionally when the upper and back part of the interventricular septum was touched. The heart was held forwards by a stitch passed through the muscle of the right ventricle. Palpation showing the bullet to be loose in the ventricle it was coaxed away from the neighborhood of the coronary vessels and grasped between the finger and thumb. Two stitches were inserted into the muscle wall over the bullet, a half inch incision made and the bullet extracted. The sutures were tied and an extra running stitch applied. The pericardial cavity was freed of blood clot, filled with saline solution to expel air, and sutured. The right pleural cavity was filled with saline solution and the pleural wound sutured. While the wound was being closed the chest was aspirated.

Pericardiocentesis.—This operation is indicated both as a means of diagnosis and of treatment. For diagnostic purposes we may use an exploring or hypodermic syringe provided with a long needle; for purposes of treatment an aspirator is required. When the pericardial effusion is non-infective, a cure may be obtained by simple paracentesis. In performing this operation, the fluid must be withdrawn slowly and the suction stopped, temporarily, whenever there is any pulmonary or cardiac distress. It is unnecessary and imprudent completely to evacuate the fluid. The usual site for introducing the aspirating needle is in the fourth or fifth intercostal space, one inch to the left of the sternum. A better position is in the sixth intercostal space immediately to the left of the edge of the sternum. This last position gives the greatest security against injury to the internal mammary artery, to the pleura, and to the heart itself.

G. Blechman (Internat. Abstracts, July, 1914) disapproves of the above methods as being likely to puncture the heart or pleura. He recommends Marfan's method. Introduce a lumbar puncture needle in the middle line immediately below the xiphoid cartilage. Pass the needle obliquely from below upward for 2 cm. along the posterior surface of the sternum, then somewhat obliquely backwards passing into the gap in the sternal insertion of the diaphragm so as to penetrate the pericardium at its base. Blechman used this method successfully seventeen times on one patient.

When there is an infective exudate in the pericardium, operation is clearly indicated. The same is true in all cases of wounds in the cardiac region when

there is marked respiratory distress with cyanosis or there is collapse with anæmia and corresponding changes in the pulse, accompanied by the physical signs of pericardiac effusion (Kocher).

Many methods have been devised by which to expose the pericardium and heart; of these, Ware gives an excellent account in the "Annals of Surgery" (October, 1899), but almost all of them, *e.g.*, those of Podrez, Niuni, etc., assume that one desires to expose the whole pericardial sac in every case and that a lesser procedure will never be efficient. Such operations consist in the formation and reflection of large flaps consisting of the skin, muscles, costal cartilages, and sternum. They require much technical skill for their performance. Wounds of the pericardium and heart call for *immediate attention*, and no extremely difficult and unnecessarily complicated method should be taught. The type of operation here taught is that described by Kocher, and any practitioner of ordinary dexterity ought to be able to perform it, in emergency, with comparatively few and common instruments. The operation has a further advantage in that no unnecessary exposure of the pericardium is called for.

Pericardiotomy.—(1) Make an incision down to the bone from the middle line of the sternum outwards towards the left side, at the level and following the line of the sixth costal cartilage. If required, the incision may extend to the left mammary line. (2) Separate the perichondrium and all the soft parts from the sixth costal cartilage and excise the cartilage. This exposes the triangular muscle of the sternum with the mammary vessels, which are ligated if necessary. Divide the tendinous insertion of the triangular muscle into the sternum. The dense, glistening pericardium now lies exposed, and if drainage alone is required, it may be opened and the operation is complete. If more room is required: (3) From the sternal end of the horizontal incision cut upwards in the midsternal line to the desired extent (usually to the level of the second rib). (4) Separate the periosteum and soft structures from the sternum to the left of the median line. Divide the fifth, fourth, and third left costal cartilages at their insertions into the sternum. (5) Through the horizontal wound push the exposed margin of pleura outwards. Gradually lift up the fifth and even the fourth and third costal cartilages, slowly and gently pushing back the pleura from their deep surface. (6) After separating the flap from the pleura, fracture or divide the costal cartilages in the flap, at their junction with the corresponding ribs. When this is done, the flap can be completely reflected. (7) Split the pericardium along the sternal margin and laterally along the fifth interspace. This gives access to the heart from the auricles to the apex of the ventricles. If more room is desired (8) excise a sufficient portion of the sternum by means of ronguer or bone forceps.

The pericardium being open, wipe away blood-clots which may be present; search for and suture with catgut or silk any cardiac wounds. Do *not* include in the suture a coronary artery. Close the pericardial wound with or without drainage. Suture or drain any pleural wounds which may be present. Don't waste time by trying to evacuate thoroughly blood from the pleural cavity; nature may generally be relied upon to attend to that better than can the surgeon.

Tully Vaughan ("Journ. A. M. A.," Feb. 6, 1909) has collected statistics of 150 patients operated on for wounds of the heart and comes to the following conclusions:

"1. There is no longer any question as to the propriety of the operation, since 35 per cent. of the patients recover, compared with 15 per cent. (according to Holmes and Fisher, 1881) of recoveries after non-operative treatment—a gain of 20 per cent.

"2. The mortality is practically the same that it was twelve years ago, when the operation was first introduced, and it behooves the surgeon to study the matter and find a means of improvement.

"3. The two great causes of death are hemorrhage and inflammation of the pleura or pericardium. Probably little more can be done than has been done to prevent death from hemorrhage, but inasmuch as more than half the patients who survive twenty hours have infection.

"4. There is room for great improvement in preventing infection. Besides the observance of strict asepsis the question of opening the pleura and of drainage of pleura or pericardium acting as predisposing cause of infection is of the greatest importance.

"5. As a rule, therefore, the pericardium and pleura should not be drained."

The principles of operation on pericardiac and cardiac wounds may be summarized as follows: (1) Cleanse. (2) Enlarge the external wound. (3) Freely expose the injured pericardium by excision of portions of the ribs and sternum. (4) Attend to hemostasis. (5) Open the pericardium and remove effused blood. (6) Attend to cardiac wounds if present. (7) Close the wounds in pericardium and in pleura if such be present. (8) Close external wound with or preferably without drainage.

In suppurative pericarditis Mintz's operation seems very practical and not difficult ("Zent. für Chir.," No. 30, 1912). Make an incision along the lower edge of the seventh costal cartilage. Separate the lower edge of the cartilage from its connections but do *not* open the peritoneum. With a periosteal elevator separate the cartilage from its posterior connections. Divide the cartilage near the sternum and also at a suitable point externally. The anterior surface of the cartilage is *not* denuded. Reflect upwards the flap of skin thus formed and so expose the pericardium. Blechman recommends Larrey's method of left subchondral incision as giving easy access to the pericardium through the epigastrium especially in children. This operation seems practically the same as Mintz's.

Cardiolysis.—When the heart becomes adherent firmly to its pericardial pouch, and that in turn to the sternum, etc., a distressing and very fatal series of conditions arise. In such cases the heart fails, because with every systole it must needs pull in along with it the osseous thoracic wall. No heart can long stand the strain of such excessive overwork. Two methods of operative treatment have been advised.

(A) Delorme's operation consists in exposing the heart by temporary resection of the thoracic wall, in opening the pericardium, and in breaking

there is marked respiratory distress with cyanosis or there is collapse with anæmia and corresponding changes in the pulse, accompanied by the physical signs of pericardiac effusion (Kocher).

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down with the hand the adhesions between the heart and pericardium. Kocher has attempted the operation on the cadaver, but never succeeded in avoiding grave injury to the heart.

(B) Petersen and Simon have successfully (three cases) carried out an operation suggested by L. Brauer. The object of the operation is *not* to free the heart from the adhesions, but to render these harmless. It is unnecessary to describe the steps of the procedure, which consist in the reflection of a flap of skin and muscle, the exposure of those ribs and that part of the sternum which impede, by their rigidity, the heart's action, and the excision of these bony or cartilaginous structures to any extent required. It is advised to excise the periosteum of the posterior surface of the sternum, lest new bone be formed. This is the most difficult step in the operation. Very careful hemostasis is essential, because, when operated on, the patient is usually very weak, but his circulation soon regains strength, and hence hemorrhage and the formation of a hematoma may supervene. Petersen advises that we should begin the operation by excising three ribs, and then, if *necessary*, remove a portion of the sternum also.

P. Lecène ("Archives des mal. du Coeur, des Vaisseaux et du Sang.," Dec., 1909; "La Presse Méd.," April 23, 1910) has collected twenty cases of cardiolysis performed by various German and English surgeons where there was no operative mortality and the results were notable and durable. After operation the heart became regular, dyspnœa ceased and the various forms of visceral stasis gradually became less, suffering disappeared and a relatively active life became possible.

Alexander Morison ("Lancet," July 4, 1908 and Nov. 20, 1909) advised thoracostomy (cardiolysis) in a case of excessive cardiac hypertrophy in aortic valvular disease associated with severe and frequent attacks of pain but with *no* costo-pericardial adhesions. Mr. Stabb operated for Morison and the results was most satisfactory. The reasoning of Morison in his paper is most convincing.

Milton's Method of Exposing the Anterior Mediastinum (H. Milton, Lancet, March 27, 1897).—Make a median incision from the cricoid to the ensiform. Expose the trachea. Carefully divide all the attachments to the sternal notch—while doing this make the knife absolutely hug the bone. If necessary nick the sternal attachments of the sternomastoids. Pass the finger gently behind the sternum from above downwards as far as possible. Either beginning at the sternal notch or at a trephine opening made through the body of the sternum near the ensiform cartilage split the sternum vertically with chisel or saw or both. Separate the ensiform from the body of the sternum. With strong sharp hooks separate the two halves of the sternum for about 1 cm. This space permits the division, under guidance of the eye, of obstructions to a further separation of 5 or 6 cm. This permits free exploration of the anterior mediastinum and through it of the other mediastina. The bone wound is easily closed by wires passed through holes bored in the bone.

Lilienthal (Surg. Gyn. & Obst.) successfully removed a mediastinal thyroid by Milton's method.

In performing Milton's operation it is not always necessary or proper to divide the whole of the sternum; division of the manubrium is often sufficient.

Milton's method will prove of service in operations upon the thymus. Kocher exposes the upper mediastinum by reflecting outwards a trap door flap consisting of skin and manubrium sterni.

OPERATIONS ON THE POSTERIOR MEDIASTINUM*

As the type of operations on the posterior mediastinum, one may take that of Nassilov, a description of which was published in 1888 and in 1899 by Stoyanov. The following description closely follows that of Nassilov: Place the patient in the ventral or semiventral position. Make an incision at least three inches in length along a line parallel to the vertebral column, and four finger-breadths from it. From each end of the vertical cut make a horizontal

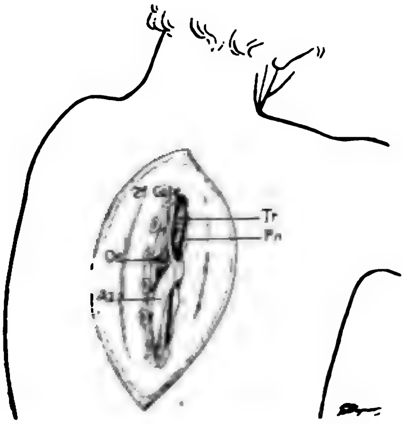


FIG. 406.—(*Schwartz.*)

incision towards the spine. Reflect towards the spine the musculo-cutaneous flap thus delimited. Resect the exposed portions of ribs subperiosteally. This requires great care because of the danger of puncturing the pleura. Should any pleural wound be inflicted, suture it immediately. The ribs should be resected close to the spine, as this gives most valuable room. The superior portion of the œsophagus (above the arch of the aorta—Bryant) is accessible after excision of portions of the third, fourth, fifth and sixth ribs on the *left* side; the inferior portion after resection of three or more of the lower ribs on the *right* side. Attend to hemostasis. Carefully separate with the fingers the posterior portion of the pleura from the remnants of the excised ribs attached to the spine. When operating on the left side, push the lung forwards with the palm of the hand and fingers; this exposes the thoracic aorta, to the right of which lies the œsophagus. The œsophagus may be recognized by palpation, and if necessary by a sound being passed into it from the mouth. By blunt

* See also section on posterior [illegible]

dissection with a grooved director separate the loose cellular tissue which encompasses the aorta, the large and small azygos veins, the pneumogastric nerves, and the thoracic duct. The œsophagus is now disengaged from its surroundings.

The accompanying figure 406 shows something of the anatomical difficulties of the operation if the first rib is not divided. Resection of the first rib permits much greater exposure of the mediastinum.

If the operation is for the removal of a foreign body from the thoracic gullet, the œsophageal wall is caught with two forceps and divided between them over the body, which is removed with forceps. The œsophageal wound may or may not be sutured; certainly free drainage of the wounded posterior mediastinum is a necessity. Small, apparently localized, cancers of the œsophagus may possibly be excised after exposure in the above manner. Inflammatory lesions of the posterior mediastinum may be exposed by Nassilov's operation and subjected to proper surgical treatment.

PART III.—THE ABDOMEN

CHAPTER XXXII

LAPAROTOMY; CELIOTOMY; ABDOMINAL SECTION

POSITION OF PATIENT DURING OPERATION

For most laparotomies the dorsal decubitus is used. When a patient lies on his back on an operating table there is always a strain exercised on the lumbosacral region, which strain subsequently manifests itself by greater or less pain in the back. This is avoided by supporting the small of the back by a small pillow, or better by so arranging the table that the thighs are slightly flexed on the pelvis and the knees moderately bent. This latter posture is particularly valuable in that it relaxes the abdomen and decreases intra-abdominal pressure. On a properly constructed table it does not interfere with obtaining the Trendelenburg posture and, according to Emmet Rixford, it does away with the necessity of adopting the Robson position in operations upon the biliary passages. Rixford has devised a table which enables the upper trunk to be slightly elevated thus increasing the benefit to be obtained from flexing the lower extremities.

During operations on the lower abdomen good exposure of the operative field may be obtained by elevating the lower end of the table, preferably with simultaneous slight flexion at the hips and knees (Trendelenburg's position). An inclination of 45° may be used.

When Trendelenburg's position is used the patient should be prevented from sliding along the inclined table by means of shoulder braces and never by letting the knees be flexed over the foot end of the table, which increases intra-abdominal pressure objectionably.

During operations in the region of the gall-bladder the intestines may be kept out of the way by placing a sand-bag about five inches in diameter under the back, opposite the lower dorsal vertebræ. (Robson's position.)

METHODS OF OPENING THE ABDOMEN

The patient, anesthetized, is placed on the operating-table. The limbs and chest are well protected with blankets. The operating-room and table are well heated. The field of operation is cleansed and surrounded by sterile cloths or towels. A good incision must (*a*) give proper access to the disease to be investigated and treated and ought to be capable of any necessary enlargement; (*b*) be capable of easy and efficient closure with the least possible danger of subsequent hernia or paralysis.

A longitudinal incision in the linea alba is classical, is easily enlarged and injures no important vessels and nerves. Unfortunately hernia is a frequent

sequel as only thin layers of aponeurosis can be coapted. To avoid this objection the cut is usually made slightly to one side of the linea alba, the sheath of the rectus is opened, the muscle either split or pulled aside and the tissues behind are cut. A longitudinal cut above the umbilicus is difficult to close because of tension. The fibres of the transversalis muscle are continued internal to the outer edge of the rectus and acting through the posterior sheath of the rectus makes suture of this structure very difficult and insecure.

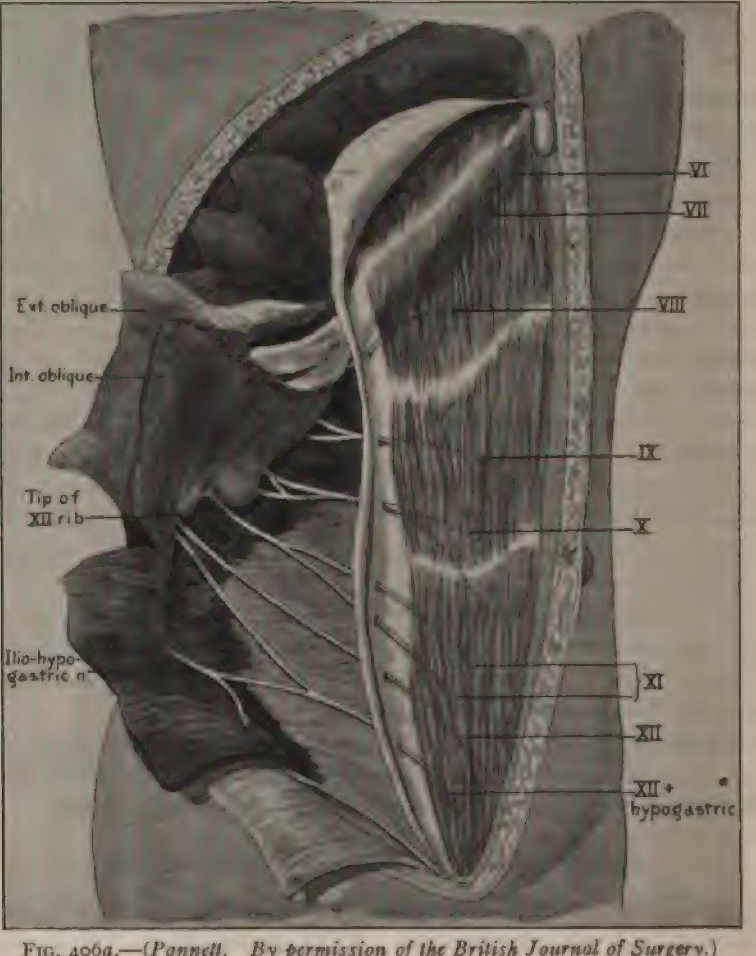


FIG. 406*a*.—(*Pannett. By permission of the British Journal of Surgery.*)

Vertical incisions through the rectus or at its outer margin destroy its nerve supply to a greater or less extent and ought to produce an objectionable paralysis of that muscle. Practically one finds few cases of serious paralytic lesions following the long vertical wounds so commonly used in the surgery of the gall-bladder and appendix, but when they do occur the surgeon wishes he had spared the nerves. For certain pieces of intra-abdominal work incisions like that of McArthur and McBurney for appendectomy are ideal as in them the different

layers of flat muscles and aponeuroses are split one after the other in the direction of their fibres and the nerves are not cut.

When one remembers that the aponeuroses of the abdominal wall are the tendons of the flat muscles (oblique and transverse), and that these are inserted into their fellows of the opposite side, one must realize that a so-called longitudinal incision is *physiologically* transverse, in that it cuts the aponeuroses (tendons) more or less transversely. This applies particularly to division of the rectus sheath but not to that of the recti muscles. Transverse division of the rectus muscle particularly above the umbilicus does not seem to weaken the muscle greatly, it rather merely adds a new *inscriptio tendineæ*. The so-called transverse incisions of the abdominal wall are usually more or less oblique or curved so as to run parallel to the course of the nerves (Fig. 406*a*). The addition of a short vertical cut in the middle line is often useful and does not materially add to the difficulty of closure.

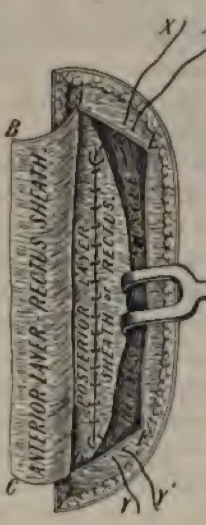


FIG. 407.

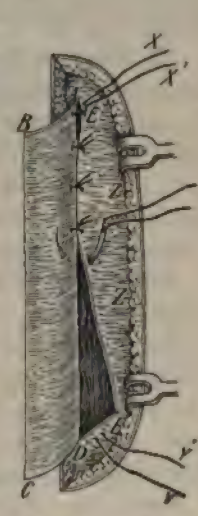


FIG. 408.

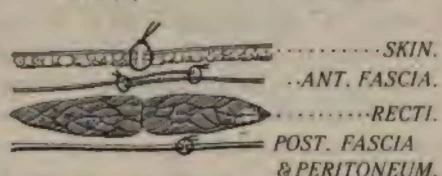


FIG. 409.

FIGS. 407, 408 AND 409.—Chevrier's incision.

In the lower abdomen an incision after the plan of Pfannenstiel is often very useful in gaining access to the pelvis. A curved transverse incision (convexity downwards) divides the skin and aponeurosis; the aponeurosis is dissected from the recti and retracted upwards and downwards, the recti are separated and the peritoneum is opened. Closure is easy and very secure. (For articles on transverse incisions, see Kocher Operationslehre; Rockey, N. Y. Med. Rec., Nov. 4, 1905; Maylard, Brit. Med. J., ii, 1907; Assmy. Beitr. z. klin. Chir., xxiii; E. Boeckmann, St. Paul Med. J., June, 1910; Sprengel, Archiv f. klin. Chir., xcii; Fritz König, Zent. F. Chir., April, 20 1912; Farr., Journ. Lancet, Nov. 1, 1912; C. A. Pannett, Trans. Surg. Sect. R. Soc., Med., Oct. 14, 1914.)

(A) **Median Incisions.**—In the middle line, either above or below the umbilicus, make an incision through the skin and subcutaneous tissues. The length of the incision varies according to circumstances, but to begin with is usually about three inches. In the linea alba divide the firm structures constituting the *essential* belly-wall. As a rule, hemorrhage will be trifling and may be disregarded, but if any vessels bleed amazingly, apply clamps or ligatures before opening the peritoneum. Pick up a small fold of peritoneum in

forceps and cautiously make a very small incision through it. When satisfied that the peritoneum is opened, catch each side of the peritoneal wound in a hemostat and by crossing the forceps, temporarily, close the belly until the hands can be once more rinsed, first in an antiseptic solution and then in water or salt solution. Enlarge the peritoneal wound; introduce the finger to explore. Enlarge the incision with scissors, if such enlargement be necessary to permit of further operative procedures.

If it be necessary to enlarge the incision beyond the umbilicus, cut around that structure generally to its left side, or even excise it, since it is not suitable for suturing and it is impossible thoroughly to cleanse it.

(B) **Chevrier's Incision.**—Incise the skin in the middle line and expose the anterior layer of the rectus sheath. Reflect the skin to one side so as to lay bare the fascia for distance of ½ to ¾ inch from the middle line. Incise the fascia about ½ inch from the middle line and reflect the fascial flap A, B, C, D, the pedicle of which corresponds to the middle line (Fig. 407). Reflect the flap a little beyond the middle line so as to expose the median border and a little of the surface of the opposite rectus muscle.

Retract the rectus so as to expose the posterior layer of the rectus sheath. Incise the sheath. In closing the wound proceed as follows: Suture the wound in the posterior layer of the sheath. In order to keep this line of suture from sliding towards the middle line, introduce at each end the sutures XX′ and YY′ which penetrate the anterior layer of the sheath, the rectus muscle and the upper and lower ends of the sutured wound. Tie sutures XX′ and YY′ only after suture of the anterior layer of the sheath.

Suture the edge (EF) of the defect in the anterior fascia to the base (AD) of the flap (A, B, C, D, Fig. 408). Tie the sutures XX′ and YY′. Suture the edge (BC) of the flap A, B, C, D to the surface of the fascia along the line Z, Z, Z (Fig. 408). Close the skin wound.

The result of the procedure is shown in Fig. 409.

(C) **Lennander's Method.**—(Kammerer; Battle; Jaboulay.) Make a vertical incision a short distance to the right or left of the median line, exposing the anterior surface of the rectus. Incise the anterior layer of the rectus sheath. Retract the inner edge of the rectus outwards, exposing the posterior layer of its sheath, and incise that layer. Open the peritoneum. Note that the rectus muscle itself is neither incised nor split, and hence its nerve-supply is not injured in the slightest. In closing the wound, remember to suture each layer of the rectus sheath separately (Fig. 410). A similar incision may be made about three-fourths of an inch internal to the outer edge of the rectus, the sheath opened, the muscle retracted inwards, and the abdomen penetrated. This outer incision is very commonly used for exposing the vermiform appendix.

Fig. 410.—Rectus incision.

(D) **Vertical Incision through the Rectus.**—This incision is excellent. Make

a vertical incision to one side of the median line down to and through the anterior layer of the rectus sheath. Split the rectus muscle by blunt dissection. Divide the posterior layer of sheath and open the abdomen.

(E) Vertical Incision at the Outer Edge of the Rectus.—This requires no special description.

(F) Transverse Incision.—As has already been stated the general direction of these incisions is transverse, but as a rule they are really oblique, curved or even angular. The direction of any part of the cut depends principally on the course of the nerves. In the region of the gall-bladder the incision usually runs more or less parallel to the costal margin, though when dividing the rectus

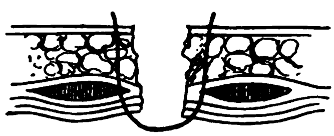


FIG. 411.

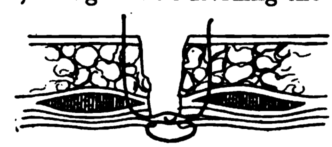


FIG. 412.

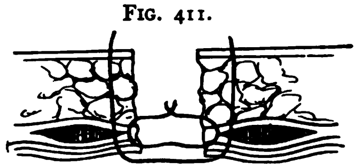


FIG. 413.

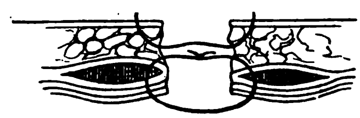


FIG. 414.

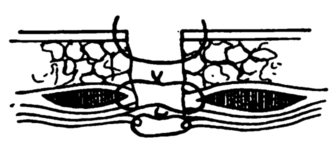


FIG. 415.

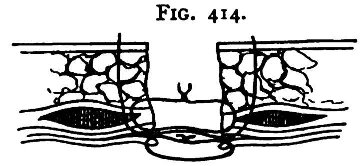


FIG. 416.

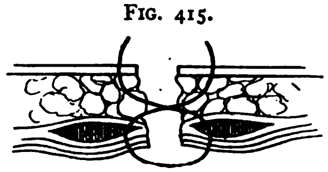


FIG. 417.

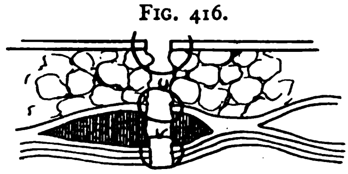


FIG. 418.

muscle the author prefers to cut at right angles to its fibres. In exposing the stomach the incision may be curved (convexity upwards), both recti being divided, or it may be transverse, one or both recti being divided in whole or in part. The incisions when prolonged beyond the recti ought always to split the fibres of the external oblique and not cut them transversely to their course. Such incisions are of the gridiron type like the McArthur-McBurney incision. In the lower abdomen the incisions are usually curved with convexity downwards.

As an example of transverse incision the method may be taken by which the author often exposes the right iliac region in cases of chronic appendicitis when considerable exploration is necessary. Make an incision in the interspinous line from the linea alba to the outer edge of the rectus and expose the rectus sheath. Introduce and loosely tie two lines of interrupted catgut stitches

transversely through the rectus sheath and underlying muscle. Divide the sheath between these lines of sutures. Cut through the rectus muscle deliberately so as to expose the deep epigastric vessels. It is almost always necessary to ligate and divide these vessels. Open the peritoneum. If it is necessary to enlarge the wound laterally this is easily done in the gridiron fashion. If median enlargement is required, the other rectus muscle may be divided without ill result. Closure of the above wound is very easy and secure. The method is not suitable in the presence of acute infective lesions.

It is specially above the umbilicus that transverse incisions are very useful.

(G) **Oblique Incisions.**—In the lower half of the abdominal wall, when it is desired to operate remote from the median line, incisions are recommended running obliquely from above downwards and inwards—*i.e.*, in the direction of the fibres of the external oblique muscle. Such avoid division of important motor nerves and permit of splitting instead of dividing the external oblique muscle. (See chapter on "Appendicitis.")

METHODS OF CLOSING THE ABDOMEN

The great object to be attained in closing the abdomen is the prevention of subsequent hernia. In the attempt to gain this end, surgeons have adopted a vast number of methods of suture. A study of the annexed diagrams (Figs. 411 to 418) will explain the suture methods more clearly than any printed description. The buried sutures uniting peritoneum or fascia are best introduced with full curved or short straight needles, and may be catgut, silk, silkworm-gut, or silver wire. The needle of A. Reverdin (Fig. 419) permits exceedingly rapid sewing. The writer prefers some form of catgut, either mildly chromicized or iodized. Kocher thinks silk the only proper material. In the Johns Hopkins clinic silver wire is used. Other surgeons prefer silkworm-gut, tendon, aluminium-bronze wire, etc. When properly used, each material does good work. When "through-and-through" sutures are used—*i.e.*, sutures embracing in their loop the whole thickness of the belly-wall—some form of handled needle, such as Reverdin's (not A. Reverdin's) or Mixter's, is most convenient and saves much time, but any good straight or curved needle of proper size will suffice. Some surgeons, *e.g.*, Jonnesco, object to the use of absorbable sutures, of non-absorbable buried sutures, and

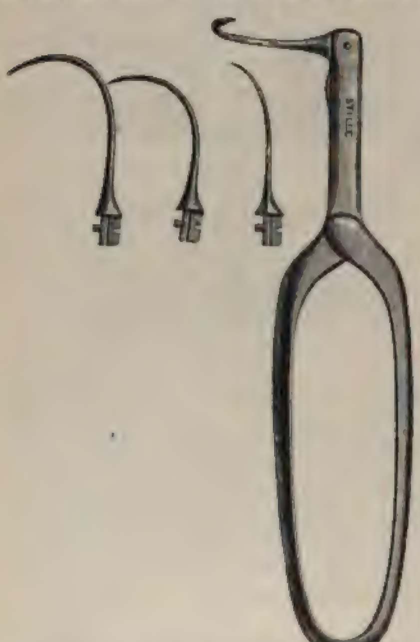


Fig. 419.—A. Reverdin's needle.

esire to close the abdominal wound in layers. For this reason they have ed more or less complicated means of suturing, so that they can remove titches when they have served their purpose (Figs. 420, 421, 422, 423).

ı extremely rare instances a wound does not heal by the time catgut es are absorbed. This peculiarity has caused a number of disasters. wise to reinforce the catgut sutures by two, three or four-silkworm-gut ation stitches.

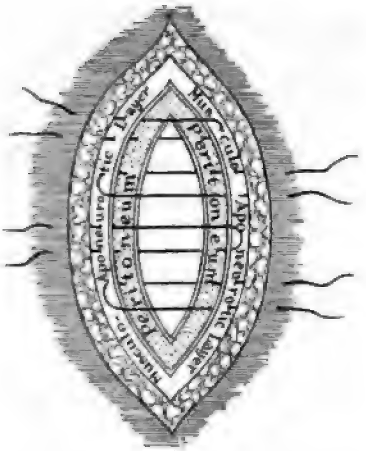


FIG. 420.—Jonnesco's method (modified).

FIG. 421.

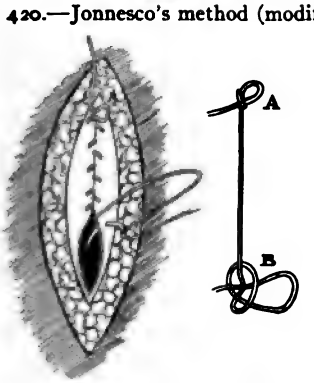


FIG. 422.—Davison's method.
A. Slip-knot to prevent suture being pulled through tissues. The free end of the suture is left projecting n the wound, and when pulled upon unties the slip-knot so permits extraction of the suture. B. Slip-knot when suture is in place. Untie the same way as A.

FIG. 423.
Continuous sutures fixed by pad of gauze at A.

The inexperienced surgeon, after completing a prolonged operation on an usted individual, sometimes forgets that it is better to have a post-operative ia in a living patient than a perfectly closed wound in a corpse. Under e circumstances it is wise to put in as few stitches as possible, and these in quickest manner possible.

When drainage has been used, it is good practice to place sutures in position the closure of the opening left by the removal of the drain and tighten and hese subsequently.

When drainage is necessary it is often wise to establish it through a special incision or stab, and then close the primary wound completely. The means used to provide drainage is liable to cause trouble in the main wound.

DRESSINGS

After completion of the operation, cover the wound with a number of pads of sterile absorbent gauze; over these place a liberal quantity of sterile absorbent cotton. Keep the dressings in place with a binder, or preferably by strips of adhesive plaster. Abundant dressings, snugly applied, support the intra-abdominal blood-vessels and prevent the patient from bleeding into his own veins after large tumors have been removed. Under ordinary circumstances the author has discarded the use of all dressings contenting himself with painting the wound daily with tincture of iodine. A sterile towel may be thrown over the abdomen, it rarely remains in position.

TREATMENT AFTER LAPAROTOMY

Return the patient to bed. A small pillow may be placed under the head, but for a short time the head must not be elevated. If there is much pain give an efficient dose of an opiate, as suffering and restlessness are greater evils than are the noxious effects of the opiate itself. Rectal instillations of salt solution are of great value in relieving thirst and in providing the patient with needed liquid. If the rectum is irritable, hypodermoclysis is often valuable. Washing the mouth with water is of value in relieving thirst and is very grateful to the patient. A. J. Ochsner stimulates secretion of saliva by letting the patient use chewing gum or hold some object like the stone of a plum in his mouth. The increased flow of saliva lessens thirst and lessens the dangers of parotitis. One must remember, however, that a too protracted increased flow of saliva may ultimately increase the thirst. As soon as nausea passes off, begin giving small doses of water, preferably hot, by the mouth. If this is well borne the patient may soon be permitted to drink two or more pints per day. Orange juice is greatly appreciated by most patients, and to it a little egg albumen may be added with advantage. In most cases liquid nourishment may be given sparingly in 12 or 24 hours after operation. If the patient likes butter-milk, this makes an excellent food to begin with. Patients rarely feel comfortable until after the bowels have moved. Sometimes an enema of soapy water with a little glycerine or turpentine fulfills the purpose. Usually on the day following operation the author prescribes calomel gr. 1/8 to 1/4 with soda every two hours until the bowels begin to grumble and then gives a saline aperient or an enema. Pituitrin is often valuable. If there is trouble in expelling flatus, a rectal tube should be introduced and left in place. Vogel and later von Hippel, impressed with the importance of the early establishment of peristalsis in the prevention of adhesions and postoperative ileus, have advised the hypodermic administration of physostigmin, mg. i, every three hours until the bowels grumble, when a rectal tube is passed to facilitate the escape of gas. On the day following operation, a glycerine enema evacuates the bowels.

ıerill and many other surgeons object to any postoperative catharsis ; that it does no good and may do much harm. This is undoubtedly when any focus of infection is present which may be disseminated by the ıf peristalsis.

w years ago many surgeons considered it essential to keep patients in sal position for a long time after laparotomy. This is cruel and in- Permit the patient to lie in whatever position is comfortable so long oes not exert tension on the wound. After certain operations—*e.g.*, n the stomach and those for peritonitis—the above rule may not prevail. perations on the upper half of the abdomen it is permissible to allow the to sit up early, as the sitting posture does not increase tension on the to any great extent. After operations on the lower half of the belly, ing posture means increased tension on the wound and hence increased hernia, therefore the author usually adheres more or less closely to the rmulated for the after-treatment of hernia operations. When the abdo- s been opened by the gridiron method of McArthur and McBurney, the emarks do not apply. The tendency of surgeons is towards letting the ı sit up and move about at an early date, even a very early date, after ın, but to the author it appears risky as tension on a wound insufficiently d is well calculated to cause hernia. The avoidance of tympany during scence is of great importance for the same reason, viz., the tension it ın the wound.

stomach tube is of enormous value after ımy. If nausea is prolonged the stomach o be washed out. If there is any evi- ıf beginning acute dilatation of the ı lavage is imperative. Half an hour ıassing the tube in a nervous patient it to give ⅛ gr. morph. hypodermatically nediately before the operation the fauces be sprayed or swabbed with cocaine.

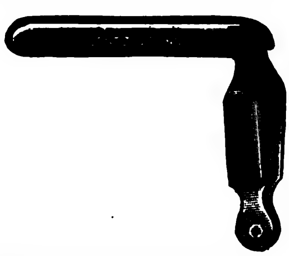


FIG. 424.—Murphy's clamp.

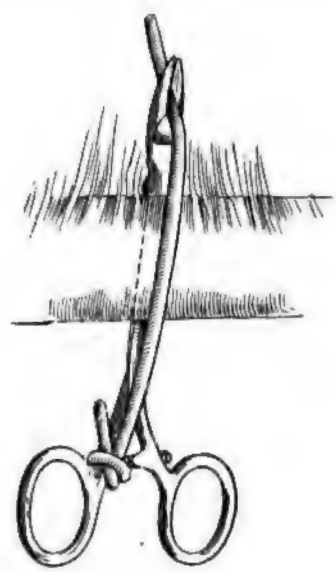


FIG. 425.—Pean's clamp.

GASTRO-INTESTINAL OPERATIONS

ıre describing the individual operations performed on the gastro-in- canal it will be convenient to consider the means at our disposal for ing the escape of its contents from an incised gut and of closing in-

testinal openings by means of sutures. Some special methods of suturing will be described later, along with the operations for which they were devised.

Preparation of a Loop of Gut for Incision.—With the finger and thumb express the contents of the selected portion of gut either upwards or downwards so as to leave that portion empty. Prevent the return of the contents to the loop of gut by appropriate clamps, applied above and below. When available, the best clamps are the fingers of an assistant exercising pressure on the gut. The objections to this are that the fingers are liable to take up too much room, and that the hands of the assistant become so fatigued that he can give but little assistance during the rest of the operation. If plenty of help is

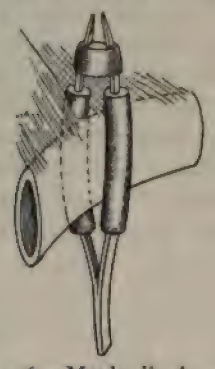


FIG. 426.—Maylard's clamp.

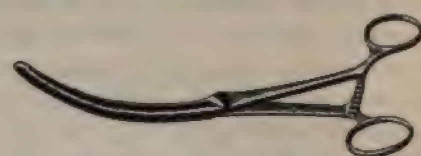


FIG. 427.—Doyen's clamp.

at hand, of course the latter objection loses its weight. Murphy's clamps (Fig. 424) are excellent. It is entirely unnecessary to protect the blades of this clamp with rubber tubing.

Pean has suggested a most convenient intestinal clamp (Fig. 425) and one which is always ready. To the proximal side of the catch of an ordinary hemostatic forceps tie the end of a soft-rubber catheter or piece of drainage-tube. Pass the point of the forceps behind the gut and through the mesentery close to the gut. Open the forceps. Place the free end of the rubber tubing over

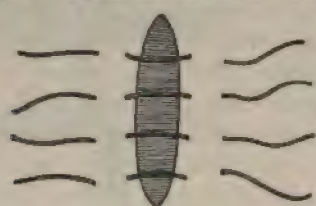


FIG. 428.

FIG. 429.

FIG. 428 AND 429.—Lembert suture.

the front of the gut; stretch the tubing and catch it in the jaws of the forceps. The result is that the gut is clamped by the rubber in front pressing towards the forceps behind.

Passage of intestinal contents may be stopped by tying around the gut strips of gauze or pieces of coarse silk or catgut. Of course, before they can surround the gut they must perforate the mesentery. Do not tie such materials tightly as little pressure is necessary and much is injurious.

Maylard extemporizes an excellent clamp by covering the blades of a dissecting forceps with rubber tubing. When the blades have been made to

grasp the intestine, their points are kept together by a segment of tubing slipped over them (Fig. 426).

All the above clamps are good for the prevention of escape of intestinal contents, but certain clamps with long blades (protected by rubber tubing) not only serve this purpose but control hemorrhage and may be employed as

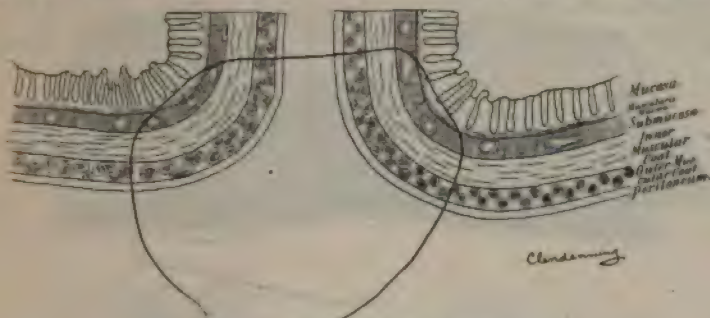


FIG. 430.—Lembert suture.

handles by which the segments of gut can be held steadily in a position convenient for suturing, etc. Such clamps are: Doyen's (Fig. 427), Hartmann's, Moynihan's, Harrington's, Scudder's, etc. A clamp good for gastro-enterostomy is good for most intestinal work.

Intestinal Suture.—The most common material for intestinal suture is fine twisted silk—preferably black. The disadvantage of silk is that when wet it is difficult to pass through the eye of a fine needle. To avoid this difficulty a sufficiency of needles should be threaded before sterilization is begun. Fine celluloid hemp is stiff enough to permit of being threaded on a needle while wet, and is in other respects as satisfactory as silk, hence is preferable. The best needles are the ordinary seamstress' needles, about one and a quarter inches in length. Various curved needles (without any cutting-edge) are useful and may be obtained in any good instrument store.

FIG. 431.—Mattress suture. (*Monod and Vanverts.*)

The intestinal wall consists of the following tunics: the serosa, the musculosa, the submucosa, and the mucosa. The submucosa is the firm, thin tunic which is used in making sausages. It provides the most reliable hold for a suture.

Lembert Suture.—This is the basis of almost all methods of intestinal suture. Its aim is to close an intestinal wound by turning the cut edges inwards and bringing the serosa of one side into apposition with that of the other side. Halsted has shown that it is wise to include the submucosa in the stitch. When a *not* too sharp needle is introduced through the serosa and musculosa, its advance is easy, but when it reaches the submucosa, a slightly increased resistance is perceptible. It is said to be easy to pick up some of the submucosa on the point of the needle without penetrating the mucosa. The author has fre-

quently endeavored to insert Lembert sutures involving the serosa and musculosa alone, but they always tore out; the picking up of a few fibres of the submucosa without letting the needle pass into the mucosa seems to be an "iridescent dream"; if any one doubts this let him try to sew two sausages together without touching the contained meat with the thread (sausage casings

FIG. 432.—Alfred H. Gould's mattress stitch.
Note that the loop is reversed. This results in the rolling in of the peritoneum on the side of the loop—B drawn to A.

consist of the submucous coat of the gut). The blood-vessels lie in the submucosa, and in suturing unless the thread is passed under the vessels (*i.e.*, nearer the mucosa) the stitches will exercise no pressure upon them and thus serious hemorrhage may, and sometimes does occur. In inserting sutures the surgeon should see to it that ***each stitch embraces firm tissue and will not cut out, and that each stitch goes under any visible vessel in its track.*** If these two rules are observed good results will be obtained no matter if the thread does pass through the deeper layers of the mucosa. The author knows of one or more cases in which the operator took special pains to insert the sutures through the serosa and musculosa alone and nearly lost the patient from hemorrhage. The introduction of the suture is sufficiently shown in Figs. 428, 429, and 430.

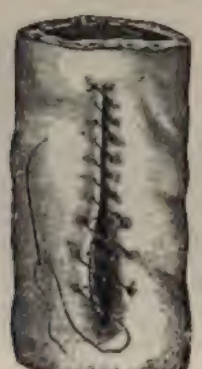


FIG. 433.—Dupuytren's suture. (*Esmarch and Kowalzig.*)

Halsted's Quilted Suture.—This is in principle identical with Lembert's. The suture is introduced after the U fashion (Fig. 431). Gould's mattress suture with reversed loop is admirable (Fig. 432).

Dupuytren's suture (Fig. 433), or continuous Lembert, can be easily and quickly applied, and when properly used, is a most excellent procedure. In America it is curious to notice that most eastern operators use the interrupted suture, while the Westerners favor the continuous. The results seem as good whichever method is employed; hence the continuous being the easier to apply, it seems to the author to be the better. It is important to observe the blood-vessels running towards the wound in the gut, and to pass the needle under such, so that when the edges of the wound are inverted by the tightening of the

res, these constrict the vessels and so prevent hemorrhage. If one fears a continuous suture will act as a purse-string and cause contraction, one obviate this danger (if danger it be) by occasionally interrupting the ıre by fixing it with a knot (interrupted continuous suture).

Several methods of closing an intestinal wound by different layers of suture e been devised. Some of these are illustrated in Figs. 434, 435, 436, 437, 438.

Through-and-through Sutures.—When closing a wound or uniting divided

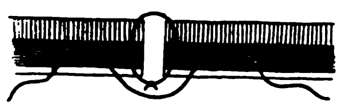


FIG. 434.

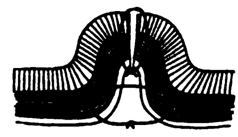


FIG. 435.

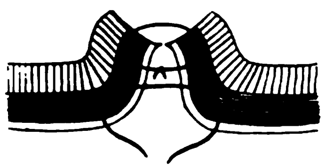


FIG. 436.

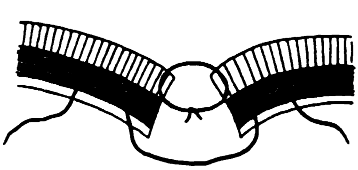


FIG. 437.

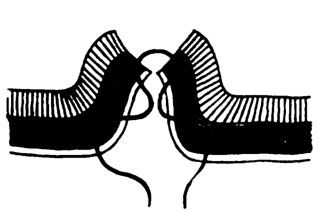


FIG. 438.

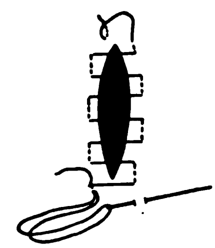


FIG. 439.

FIG. 440.—Gely's suture.

ends of gut there is often considerable hemorrhage and some danger of the line of Lembert sutures becoming infected by intestinal contents. To control hemorrhage nothing is better than to unite the edges of the wound with a continuous stitch of catgut or silk penetrating all the thickness of the gut-wall. This line of suture is at once covered and hidden by a row of Lembert or Dupuytren sutures, and serves to protect the latter from infection. Cushing's and Gely's methods of suture are sufficiently explained by Figs. 439 and 440.

CHAPTER XXXIII

THE STOMACH

Exploratory Operation on the Stomach.—At least one day prior to operation thoroughly wash out the stomach with warm water. Repeat this lavage immediately before the operation. Be careful to empty the stomach completely. If the stomach has been for a long time much dilated, do not empty it during the first lavage. Under these circumstances preparation should consume several days. If the organ is suddenly or rapidly cleaned, tetany is very liable to develop. In dehydrated patients, *i.e.*, those who pass not more than 500 c.c. of urine in twenty-four hours, it is of vital importance to give hypodermically from 40 to 60 ounces of saline solution per diem for several days before operation.

When diseased, the stomach almost always lies at a lower level than in health, hence the incision need not be so near the ensiform cartilage as might be imagined from a study of normal anatomy.

Having opened the abdominal cavity, introduce the finger and palpate the stomach and its surroundings. This is often sufficient for diagnosis. If it is not sufficient, pull the stomach into the abdominal wound, surround it with warm pads, and inspect the anterior gastric wall. If a pyloric stenosis is suspected, invaginate a part of the stomach-wall with the finger so that the finger penetrates and palpates the pylorus. Gentleness must be employed. If it is desirable to explore the interior of the stomach, *e.g.*, for ulcers, pack the abdominal cavity around the stomach with warm gauze pads. It is universally advised to count the pads before beginning the operation. This is a good rule. A rather better precaution against losing and leaving a pad in the belly cavity is to have 6 inches of soft tape sewed to each pad, and as the pads are introduced into the belly to let the tape emerge from the wound and be anchored by a hemostat. The tapes emerging through the wound are never in the way. The pads used should be large. Those 24 inches long by 6 inches wide are good. The writer makes it a rule never to place a pad in the abdomen without an anchor affixed, and never to use other pieces of gauze for sponging inside the cavity unless they are held in sponge forceps. These rules are simple, and hence efficient.

Have an assistant pick up a fold of the anterior wall of the stomach. Incise this fold in a direction at right angles to the long axis of the organ. If there is fluid in the stomach and its walls are not weakened too much by disease, introduce a blunt tube and empty the viscus. Introduce the finger into and palpate the stomach. Retract the edges of the wound and inspect the interior. In doing this a rectal speculum provided with a diaphragm and

2½ inches long by 1½ in diameter is of great aid and permits inspection of the duodenum through the pylorus. Close the gastric wound by sutures of catgut involving the whole thickness of the wall; this row of sutures to be inverted or buried by a series of Lembert or continuous Lembert stitches. Close the abdomen. Return the patient to bed. Keep him warm.

Thirst, and later hunger, may be relieved by warm water or nutrient enemata. If possible, do not give anything by the mouth for at least twelve hours, and then only water. Remember that the danger arising from giving drink or food by the stomach in such cases is really *not* from its leaking through the wound, but from vomiting being set up by its presence, and also from its stimulating effect giving rise to peristalsis, etc.* Hypodermoclysis or rectal instillation of salt solution is of inestimable value in these cases. It is desirable that the stomach rest until repair is advanced. If there is much pain, morphine in an efficient dose should be given. If possible to avoid the use of morphine without cruelty, do so, but when its employment is decided on, administer in one dose enough to insure the effects desired.

Exploratory operations are strongly indicated "in cases of rapidly developing cachexia and emaciation with the symptoms of chronic gastritis and absence of HCl. Tentative treatment should not be prolonged over three weeks. It is not near so serious a fault to have caused the opening of a stomach and found nothing operable, as to permit a case to continue and find out at the autopsy only that it was a circumscribed carcinoma, the removal of which might have prolonged life for years." (Hemmeter, "Dis. of Stom.," p. 358).

Operation for Cardiospasm.—Mikulicz observed a number of cases in which the patients suffered severely from œsophageal obstruction due to muscular spasm at the œsophageal-gastric junction. When milder means of treatment failed he obtained complete cure by opening the stomach, passing an instrument like a glove stretcher into the œsophagus through the stomach and thus forcibly stretching the muscle at fault. Brünig has opened the blades of the Mikulicz's forceps as much as 2¼ inches (6 cm.) with excellent results.

Dilatation by means of air or water bags introduced through the mouth has practically entirely displaced the Mikulicz operation. See Plummer, "Journ. A. M. A.," Aug. 15, 1908.

Operation for Ulceration of the Stomach.—It is tempting to advise operation in cases of acute ulceration where there is a copious hemorrhage, but recovery generally ensues under medical treatment and operation is proper only when the hemorrhage is not merely copious, but recurrent. Moynihan advises strongly against any search being made for the bleeding point; a gastro-enterostomy will cause all hemorrhage to cease and permit the ulcer to heal. Ulcers of the stomach not producing stenosis ought to be buried

* Possibly too much weight is given to the dangers of early feeding. Roux is extremely heterodox, feeding his gastro-enterostomy patients with almost anything they desire as soon as they desire it.

by invagination with sutures, or better, they ought to be excised. Unless the invagination or the excision gives rise to stenosis, gastro-enterostomy ought not to be performed. Every chronic gastric ulcer with hemorrhage demands operation. Duodenal ulcers require excision or invagination to produce permanent stasis plus gastro-enterostomy, otherwise the relief afforded by the gastro-enterostomy permits partial healing of the ulcer, a return of the pyloric function and a return of the symptoms. Excision of duodenal ulcers is rarely necessary as these ulcers have little tendency to become malignant. In all cases of chronic gastric ulcer with hemorrhage operation is indicated. When ulcer gives rise to gastric dilatation, to hourglass stomach, or to gastralgia and dyspepsia, operation is called for; in fact, inveterate dyspepsia warrants operation after the failure of a fair trial of medicinal means of treatment.

Donald Balfour (Sur., Gyn., Obst., xix, 528) has had very good results from the use of the cautery. If the ulcer is on the lesser curvature he carefully dissects free the adjacent lesser omentum and then burns the ulcer completely with a Paquelin cautery kept at a dull heat. This of course perforates the stomach. The wound is closed by a few through-and-through chromicized catgut stitches and these are buried by interrupted sutures of linen. The reflected lesser membrane is replaced and fixed to the site of ulceration. In suitable cases the peritoneum and muscularis may be reflected as a flap from over the ulcer; the ulcer slowly burned; the perforation closed with catgut sutures and the flap replaced. (Mayo, Journ. A. M. A., Sept. 25, 1915.)

In cases of uncomplicated ulcer Mikulicz recommends medical treatment unless the disease is very persistent or recurrent, when operation is proper, especially among the working classes. In other non-malignant affections of doubtful origin, notably those of a nervous character, he considers operation improper.

One must always bear in mind that in pure neurasthenia many of the symptoms of gastric ulcer may be present, the stomach may be dilated, etc., and the patient may be in such a frame of mind as to tempt the surgeon to perform gastro-enterostomy. If the abdomen is opened and no scar of ulcer is found and there is no enlargement of the gastric lymph nodes indicating ulcer, do not perform gastro-enterostomy, as the latter state of such a patient is very liable to be worse than the first. The most experienced surgeons are becoming more and more skeptical as to the existence of the so-called "mucous ulcers" which cause bleeding but cannot be *seen* either on the operating or postmortem table.

Whenever there is perforation of the gastric wall from ulceration, operation is imperative. Excision of the ulcer is unnecessary. All that is necessary is to close the ulcer with a single stitch of catgut and to infold the ulcer and a portion of healthy stomach with two rows of continuous Lembert sutures. (Moynihan.) If there has been much soiling, flush the cavity; "if the operation is done within ten or twelve hours, a gentle wiping of the surrounding area with wet swabs will suffice. Drainage, as a rule, is not necessary except in the late cases. When adopted it should be free, a split tube

and a gauze wick being placed in the original incision and in a second suprapubic opening." Do not be content with finding and closing one perforation: look for more.

When operating for perforating ulcer, if the patient is in very poor condition, it is often wise to follow W. G. Richardson's advice (Northumberland and Durham Med. J., Nov. 12, 1903) and pass a rubber tube through the perforation into the stomach. By stitching the stomach surrounding the tube to the parietes a fistula is established through which the stomach may be washed and food administered. After a few days the tube may be removed and usually the opening closes spontaneously.

In the preceding remarks no account has been taken of the presence of adhesions, or of scars and stenoses resulting from ulceration. Adhesions are Nature's means of protecting the peritoneal cavity from general infection, but while immediately life-saving, they are very liable to occasion much gastric disturbance, and certainly make operative interference much more difficult. The mere breaking-down of gastric adhesions (gastrolysis) often suffices to cure apparently inveterate cases of dyspepsia. Mayo Robson ("Transactions Am. Surg. Association," xix) has carried out this treatment fifty-six times with complete success. Before closing any perforation or before uniting bowel to stomach, if adhesions exist, they must be so broken down or divided that the parts to be united tend to lie together, and the sutures when inserted keep the parts together *without any tension. Tension on sutures is fatal.* The technical difficulties occasioned by adhesions may dominate the choice of operation for the relief of ulcer or its sequelæ.

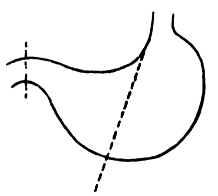


Fig. 441.

More than 90 per cent. of gastric ulcers are situated along the lesser curvature, often constituting the so-called saddle ulcer where the disease extends on to both the anterior and posterior walls of the stomach. Ulcers not along the lesser curvature are more frequent on the posterior than the anterior wall of the stomach. Less than 6 per cent. of the ulcers seen are multiple (Mayo). It is very commonly accepted that chronic gastric ulcers may and do act as the starting-point of malignant disease. Influenced by the above consideration, Rodman[1] has suggested the advisability of excising the pylorus and that portion of the stomach most commonly the seat of ulceration. The lines of incision advised by this surgeon are shown in Fig. 441.

Excision of Gastric Ulcers.—Codman points out that ulcers of the stomach are practically always confined to the lesser curvature; when they are apparently posterior, it is because adhesions to the pancreas, etc., so twist the stomach as to make the lesser curvature appear to be the posterior wall of the viscus. Excision of the ulcer-bearing area, when done in the classical fashion, sacrifices unnecessarily the greater curvature, renders difficult the closure of the gastric wound near the œsophagus and does not permit of thorough exploration of the interior of the stomach.

Codman operates as follows (personal communication):

Step 1.—Open the abdomen and explore.

Step 2.—Divide the gastro-hepatic omentum. Divide the gastro-colic omentum leaving intact the left gastro-epiploic vessels. Doubly clamp and divide the duodenum near the pylorus. Treat the duodenal stump ***secundum artem*** and let it drop back into the abdomen.

Step 3.—At this point the jejunum should be sought and pulled upward through a slit in the transverse mesocolon. A clamp is applied to it in the usual manner and it is left ready to take part in the gastro-enterostomy.

Step 4.—Pull the mobilized stomach out of the abdomen. Apply an intestinal clamp to the stomach close to the œsophagus and permit the clamp (well protected by gauze) to go inside the abdomen. This clamp should have short handles. It should be applied to the stomach at right angles to the direction in which clamps are usually placed—that is, it should clamp the stomach transversely. Cut an appropriate slit in a large sheet of rubber dam. Pull the mobilized stomach through this hole and spread the rubber dam as a protection over the whole territory of operation so that no stomach contents can soil the abdomen. The clamped jejunum can be palpated through this rubber sheet and when it is needed the rubber can be incised.

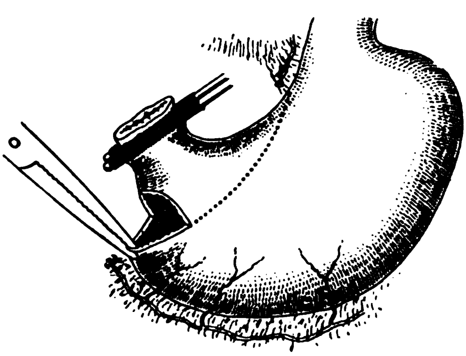


Fig. 442.

Step 5.—Make a free cut across the greater curvature at a point chosen so that the tip of the greater curvature flap will easily extend to the point of division on the lesser curvature (Fig. 442.) The gastro-epiploic vessels are of course ligated at the point of section.

It is the fact that both curvatures are sutured transversely that makes them so much easier to suture and turn in than when one is dealing with a corner or a point. By this method the corners come in the free part of the stomach where there is no tension.

When the cut in the greater curvature is made, the latter is held up so that when it is divided nothing but gas will escape. Beginning on the greater curvature near the pylorus cut through both the anterior and posterior walls on a line directed towards the œsophagus and so excise the whole lesser curvature. At this point all of the stomach can be carefully cleaned out and inspected as far as the œsophageal clamp. If necessary the clamp can also be removed and still more of the lesser curvature excised. If the two main vessels are tied, the hemorrhage from the free edge may be ignored for a few minutes. Before completing the section it is well to apply forceps or a stout stitch to the stomach near the œsophagus and proximal to the line of section in order to insure against the stump slipping through the intestinal clamp. Ligate the coronary vessels.

Step 6.—Incise the rubber dam and secure the clamped loop of jejunum. ay the greater curvature of the stomach at a suitable place over it having made button hole in the posterior wall. Through this pull the loop of jejunum the clamp remaining outside the stomach). Working inside the stomach, pen the loop of jejunum and complete the gastro-enterostomy (exactly as in Maunsell's end-to-end enterorrhaphy) in the simplest possible manner. (Codman says that any method of suture suffices as long as the edges of the sutured wound project into the stomach; he believes that a single row of ordinary close sewing is enough.) Remove the lamp from the jejunum. If there is ny bleeding from the gastro-enterostomy wound it is easily stopped by a itch or two.

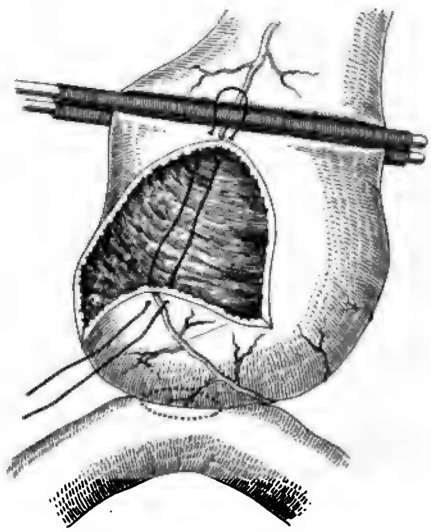


Fig. 443.

Step 7.—The greater curvature and ljacent stomach wall form a large ip, well nourished by the left gastro-iploic vessels. With a mattress ture unite the end of the above flap the upper end of the stomach wound such a fashion that the coronary ssels and the distal divided end of le left gastro-epiploic vessels are encircled by the stitch and the edges of he wound are everted (Fig. 443). Complete the closure of the stomach by neans of sutures so introduced that the wound is everted, that is, mucosa to mucosa. Remove the clamp controlling the gastric circulation. If any bleeding occurs it *must* be visible and so easily controlled because the edge of the wound is slightly everted. The preferable suture material is chromicized catgut.

Bury the everted line of sutures by a continuous layer of silk sutures.

Step 8.—Remove the rubber dam and gauze protection. Restore the organs to the abdomen. Close the abdomen.

Codman claims for this operation that the lesser curvature can be removed up to the very edge of the œsophageal opening. By the use of a double-headed suture the flap made by the greater curvature is readily drawn up. The completion of the gastro-enterostomy has been made with ease and the usual difficulty of attaching the jejunum to the stump is avoided. But the main point is that unsuspected soft ulcers may be detected when the stomach s open.

The presence of ulcers or of their sequelæ is the most common occasion or operations on the stomach. When ulcers are present, the lymph nodes orresponding to the diseased area are generally enlarged and form a good uide to the location of the disease.

Gastrostomy.—The object of gastrostomy is to make a convenient fistula

into the stomach through which nourishment can be administered. Œsophageal stenosis is *the* indication for the operation, hence we have usually to do with emaciated and weak patients. The simplest method of operating is the worst. It consists in performing an exploratory gastrotomy and suturing the stomach wound to that in the parietes. The objection to the above method is that it permits a constant escape of the gastric juices. All the other methods of gastrostomy are attempts to avoid the above-mentioned fault.

(A) *Gastrostomy with Formation of Sphincter* (Hartmann; Terrier; Jaboulay, etc.).—By percussion and palpation define the lower edge of the liver in the epigastrium.

Step 1.—Make a vertical incision 1 to 1½ inches to the left of the median line, beginning at the lower edge of the liver and running downwards for about 2½ to 3 inches. Divide the anterior layer of the muscular sheath and split the rectus itself, but do *not* yet divide the posterior layer of the sheath.

Step 2.—Retract the wound inwards and thus expose the posterior layer of the rectus sheath and divide it along with the peritoneum near the median line.

Step 3.—Introduce the finger and pass it up under the left lobe of the liver to the portal fissure, and follow the gastro-hepatic omentum to the lesser curvature of the stomach. (Maylard, "Surgery of the Alimentary Canal.") This avoids all danger of mistaking colon for stomach. Pick up the anterior wall of the stomach and pull a cone of it through the wound. Close all the excess of peritoneal wound.

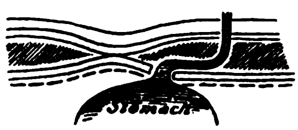


FIG. 444.—Gastrostomy.

Step 4.—Remove retractors and permit the rectus muscle to resume its normal position (Fig. 444).

Step 5.—Close all excess of abdominal wound and suture the protruding cone of stomach to the skin. Open the protruding portion of stomach and introduce a soft catheter into it.

Steps 1 and 2 may be varied as follows: Divide the anterior layer of rectus sheath along the line of the skin-incision; retract it inwards, *i.e.*, to the right; retract the whole rectus muscle outwards, exposing and dividing the posterior layer of sheath and the peritoneum near the median line; pull out the cone of stomach; split the rectus muscle along the line of the skin-incision and separate the internal portion from its posterior layer of sheath; pull the cone of stomach through the bridge of muscle thus formed and suture to the skin (Figs. 445 and 446).

(B) *Frank's Operation.*—*Step* 1.—Beginning near the lower edge of the liver, make an incision downwards and towards the left, parallel to and one inch below the left costal cartilages. Length of incision, 2 to 3 inches.

Step 2.—Through the incision pull out a cone of stomach from as near its cardiac end as is possible without too much tension.

Step 3.—Make a second skin-incision, about 1½ inches in length, parallel

first and situated over the left costal cartilages. Undermine the skin n the two incisions and pull the cone of stomach through the tunnel rmed. Suture the stomach to the skin at the second incision.

4.—Close the first wound without exerting too much pressure on the f stomach which traverses it. Open the apex of the stomach cone. sult is an oblique valvular fistula.

nk's operation has the disadvantage that, the stomach being small, culiar formation of the fistula causes a deformity which seriously in- s with the carrying on of the normal functions.

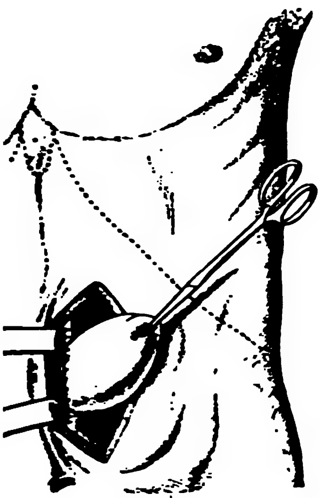


FIG. 445.

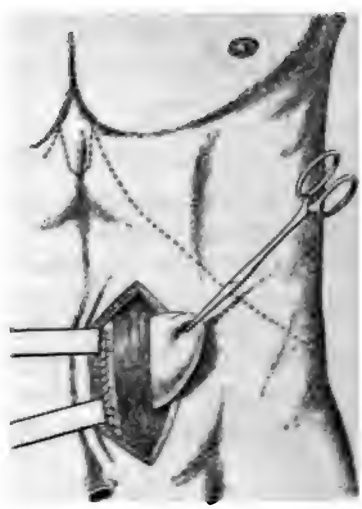


FIG. 446.

445 AND 446.—Hartmann-Terrier-Jaboulay gastrostomy. (*Moned* and *Vanverts*.)

Witzel's Operation.—The object of this operation is to form an efficient between the stomach and the skin and to make it oblique, so as to t leakage of gastric juices. In time the obliquity is lost, but yet leakage t take place.

Operation.—Open the abdomen through the rectus muscle by a two- rtical incision to the left of the middle line. From the junction of the of the stomach and its pyloric portion pull into the wound a fold of the h near the greater curvature, and here make a small incision, about the of a lead-pencil, through the serosa and musculosa. Pick up the mucosa forceps and open the stomach cavity. Take a soft-rubber catheter, about 5 Fr.: close one end of the catheter or tube with a clamp and introduce er end into the stomach. Fix the tube to the gastric wound with one catgut sutures. Lay the proximal portion of the tube on the surface stomach and bury it by a row of Lembert or continuous Lembert sutures. n in Figs. 447 and 448. This forms a canal in the stomach-wall. The uld be 1¾ inches in length or longer. Unite, with sutures, the outer of the canal to the parietal peritoneum. Bring the free portion of

the tube out through the abdominal wound. Close the excess of abdominal wound. Over the portion of the tube external to the abdomen slide a short segment of a larger tube fitting snugly to the main tube. This outer ring of tubing is pushed up to beside the skin, and through it is passed a safety-pin to prevent the drain from penetrating too far into the stomach. If the

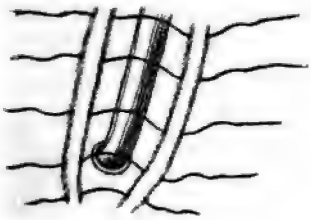


FIG. 447.

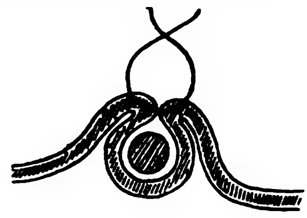


FIG. 448.

FIGS. 447 AND 448.—Witzel's gastrostomy.

safety-pin was introduced into the main tube, stomach contents could leak out alongside of it and irritate.

(D) *Stamm-Kader Operation.*—Expose and open the stomach as in the Witzel operation. Introduce a rubber tube and, with catgut, suture the edge of the gastric wound to the tube. With celluloid hemp or silk suture the gastric serosa, about ¼ inch distant from the wound, to the side of the tube all around it a short distance from the wound (Figs. 449 and 450). Insert a second row of these serious sutures. This causes an inversion or invagina-

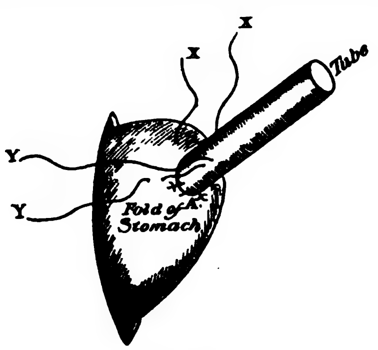


FIG. 449.

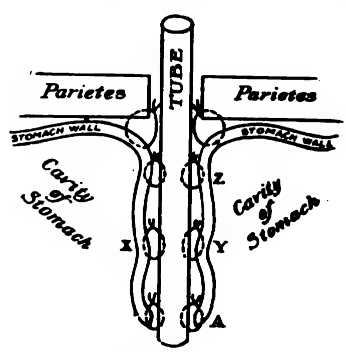


FIG. 450.

FIGS. 449 AND 450.—Stamm-Kader gastrostomy.

tion of the stomach-wall, which serves as an efficient valve. With Lembert sutures unite the stomach around the tube to the parietal peritoneum. Bring the outer portion of the tube through the abdominal wound at a convenient point. Close the excess of abdominal wound. The Stamm-Kader operation is the only one applicable when the stomach is much diminished in size. It is an excellent, perhaps the best, method of operating.

An easier method of performing the operation is as follows:

Introduce a purse-string suture of catgut all around a small opening in

e stomach-wall exactly as when a Murphy button is to be used. Through ie opening pass the bulb of a Jacob's self-retaining catheter into the stomach. ull the catgut suture snugly round the shaft of the catheter and tie it. Introduce a purse-string suture of hemp or silk in the stomach-wall round and bout 1/2 inch distant from the catheter. As this suture is tightened push he catheter inwards and invert or invaginate the stomach-wall. Tie the uture but leave its ends long. Using the catheter as a handle pull the stomach p against the abdominal wall. With a needle fix the long ends of the purse-string suture to the peritoneum or the fascia of the abdominal wall. If desired introduce one or two sutures to unite the stomach, near the gastrostomy opening, to the peritoneum. (This is usually superfluous.) Close the abdominal wound. The catheter protrudes through the abdominal wall and aids in keeping the stomach in contact with it.

When the catheter has served its purpose it may be cut off flush with the skin and its bulbous end permitted to drop back into the stomach.

(E) **H. H. Janeway's Gastrostomy** (Journ. A. M. A., July 12, 1913).—*Step* 1.—Make a vertical incision through the inner third of the left rectus muscle beginning at a point about 1½ inches below the costal margin. Open the abdomen.

Step 2.—Pull out of the wound a fold of the anterior wall of the stomach slightly to the right of the abdominal incision and anchor it with forceps.

Make an incision into the stomach about 1¾ inches in length along a line slightly oblique from above and the left to the right and downwards. This incision is nearly transverse to the long axis of the body. At each end of the incision make a cut about ½ inch long directed towards the greater curvature.

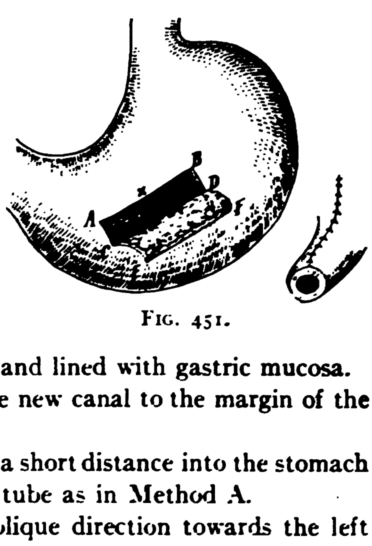


FIG. 451.

Step 3.—Make traction upwards at the point X (Fig. 451). Unite the edges X A C E of the gastric wound to the edges X B D F. The result is a tube about 2 inches in length and lined with gastric mucosa.

Step 4.—*Method A*.—Suture the base of the new canal to the margin of the rectus sheath and its tip to the skin.

Method B.—Invert the base of the canal for a short distance into the stomach so as to form a valve. Treat the rest of the tube as in Method A.

The canal if made as described has an oblique direction towards the left and is therefore in itself valvular. It is completely lined by mucosa and hence continuous catheterization is not necessary in order to keep it open.

After-treatment.—It is better to administer nourishment per rectum for a few days after the operation, lest vomiting be set up. If the patient is urgently in need of nourishment, it may, however, be at once introduced by the catheter into the stomach. For weeks after operation the diet should be liquid; later food well broken up or chewed by the patient may be permitted.

Gastroplication.—This operation is occasionally performed in cases of gastric dilatation. It is exceedingly simple and has for its object the diminution in size of the stomch.

Step 1.—Open the abdomen and expose the stomach.

Step 2.—Into the anterior surface of the stomach introduce several rows of exaggerated Lembert sutures or some modification thereof. The result is an invagination of segments of the stomach-wall and consequent decrease in calibre (Fig. 452).

This operation is not curative, in that the cause of the trouble is not touched, and relapse is the rule.

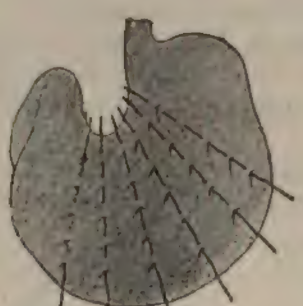


FIG. 452.—Gastroplication. (*Monod and Vanverts.*)

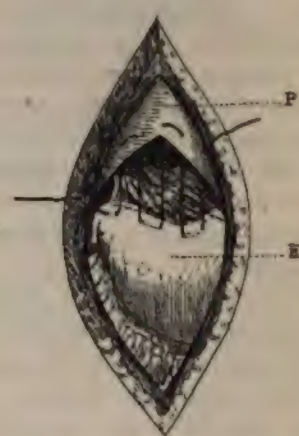


FIG. 453.—Duret's gastropexy. (*Monod and Vanverts.*)

Gastropexy.—This operation has been performed when, on account of gastroptosis, the patient has become a chronic invalid; suffers severely; is much emaciated, and none of these conditions is satisfactorily relieved by the ordinary non-operative methods of treatment. The object of the operation is to restore the stomach to, and retain it in, its normal position, and thus prevent dragging upon the gastro-hepatic omentum and pressure upon the intestines and pelvic organs, as well as obstruction to the onward passage of food from the stomach offered by kinking of the duodenum. The condition present is usually one of general visceral ptosis, hence the operation is commonly futile.

Duret's Operation.—*Step* 1.—Make an incision in the median line. Open the peritoneum and expose the stomach in the lower part of the wound. Expose but do *not* open the peritoneum in the upper part of the wound.

Step 2.—Insert a continuous suture on the modified Lembert plan, so as to unite the stomach and upper undivided portion of peritoneum. When this suture is in place, make both ends of it penetrate the fibromuscular belly-wall and tie them there (Fig. 453).

Step 3.—Close the wound.

Rovsing's Operation.—Step 1.—Make a median incision from the ensiform ırtilage to the umbilicus.

Step 2.—With the finger pull the stomach upwards to its normal level. ;xamine the pylorus for stenosis, etc.

Step 3.—Introduce fairly stout silk sutures as in Fig. 454. Do not tie ıem until the surfaces of the stomach and parietal peritoneum are scarified ·here they are to be apposed and the belly-wall is sutured.

Step 4.—Close the abdominal wound and place on it a pad of gauze or plate of glass covered with sterile gauze the dimensions of which are a little reater than the stomach-surface which has to be fixed. Over the gauze pad r glass plate tie the sutures suspending the tomach. These sutures are left *in situ* for three r four weeks.

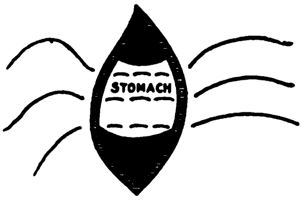


FIG. 454.—Rovsing's gastropexy.

The operation is not dangerous and has given ome strikingly brilliant results. ("Archiv f. klin. :hir.," lx, 816.) Rovsing reports the following esults: Complete cure, 63.2 per cent.; great imrovement, 12.8 per cent.; improvement, 7 per ent.; slight improvement or no change 12.8 per ent.; deaths, 4.6 per cent. None of the deaths could be fairly attributed to he operation (Trans. Surg. Section A. M. A., 1912).

Gastropexy (*Beyea's operation*) has been accomplished by means of shorten- ıg the supports of the stomach. The lesser omentum is thrown into trans- 'erse folds, which are rendered permanent by a few sutures. In introducing he sutures be careful not to include any blood-vessels in their bite. Sir Frederic :ve ("Brit. Med. Journ.," May 7, 1910) is a thorough advocate of a slight ıodification of Beyea's operation. The liver is well raised by an assistant nd the lesser omentum fully exposed. The stomach is suspended by four r five interrupted silk sutures passed above through the upper part of the astro-hepatic omentum and below through the lesser curvature *in front* f the vessels. The lesser omentum is much thicker close to the liver than it ; lower down but if the whole membrane is equally thin then the sutures re passed through the liver substance itself, just anterior to the transverse ssure. Of seven cases operated on as above and observed for a sufficient ime afterwards, six were cured.

Gastrectomy.—(A) *Partial gastrectomy* is indicated in cases of limited nd well-localized tumors of the stomach-wall, as well as in cases of ulcera- ion. After the removal of the diseased tissue the wound is to be closed y a line of continuous sutures, either involving the mucosa alone or the ʳhole thickness of the stomach-wall. This line of deep sutures is to be uried by one or sometimes two lines of Lembert or continuous Lembert utures.

When a saddle-shaped ulcer or any disease situated on the lesser curvature ; excised, the manner of closing the wound is very important. If the re- ulting wound is closed in the long axis of the stomach, a certain amount of

necessary contraction gives rise to an hour-glass stomach (Fig. 455), the wound must be closed transversely. A good way to operate is as follows:

Step 1.—On each side of the ulcer apply a ligature to the coronary vessels. Make a longitudinal slit in the gastro-hepatic omentum above the ulcer. Through this slit apply a volsellum to the posterior wall of the stomach about ¾ inch beyond the posterior limits of the ulcer. At a corresponding point on the anterior surface of the stomach apply a second volsellum. By lifting the volsella, a transverse fold of stomach is brought forwards (and lies anterior to the gastro-hepatic omentum) consisting of the ulcer and portions of the anterior and posterior gastric walls.

FIG. 455.—Excison saddle ulcer. Wrong method.

Step 2.—Apply an intestinal clamp to the fold. The blades of the clamps are at right angles to the long axis of the stomach (Fig. 456).

Step 3.—Excise the ulcer. Payr dries the mucosa with gauze and paints it with tincture of iodine so as to lessen infection. Close the wound with catgut sutures applied in the Connel fashion. Remove the clamps. Apply a second row of sutures (silk or hemp) in the Lembert fashion. The wound is so closed that its scar is transverse to the long axis of the stomach.

Step 4.—Close the wound in the gastro-hepatic omentum.

For Codman's excellent method of operating, see p. 355.

Transgastric Partial Gastrectomy.—If an ulcer exists on the posterior wall of the stomach and is adherent to the pancreas it may be possible to gain access to it by penetrating both the gastro-hepatic omentum and the transverse meso-colon and then to divide the adhesions, excise the ulcer and close the wound in the stomach. W. J. Mayo has found it much easier in several cases to perform a transgastric operation as follows: Incise the anterior wall of the stomach by a vertical incision; note the extent of the ulcer and its adhesions; incise the posterior wall of the stomach from the inside around and close to the ulcer. Remove the ulcer, if necessary shaving off a thin surface of pancreas. This shaving of the pancreas is not so formidable as might be

imagined, because the inflammation which has made it adherent to the stomach has converted the adherent portion, to a large degree at least, into scar tissue. Close the posterior gastric wound by a row of serous sutures, then by a row of through-and-through chromicized catgut sutures (Fig. 457). Close the anterior wound in the stomach.

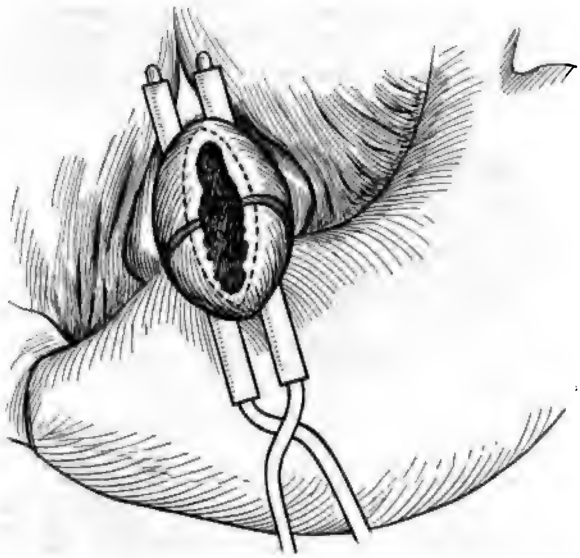


FIG. 456.—Excision saddle ulcer.

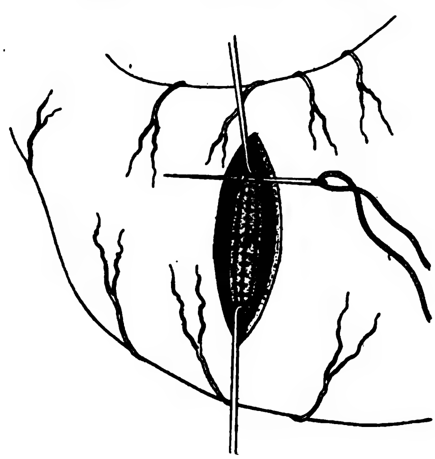


FIG. 457.—Transgastric excision of ulcer on posterior wall of stomach.

(B) *Complete gastrectomy* is indicated when the whole stomach is affected by malignant disease; or if only one part is evidently affected, the rest is in a suspicious condition. It is useless to attempt a complete gastrectomy if neighboring structures are involved. Connor first performed this opera-

tion in 1889. The patient lived forty-eight hours. Schlatter subsequently and independently operated; his patient died one year afterwards from recurrence.

The Operation.—Open the belly in the middle line by an incision extending from near the ensiform cartilage to the umbilicus. Divide the greater and lesser omenta after securing their vessels by chain ligatures. The stomach remains attached to the body by the œsophagus and duodenum. Pull the œsophagus downwards as far as possible and apply a clamp to it at as high

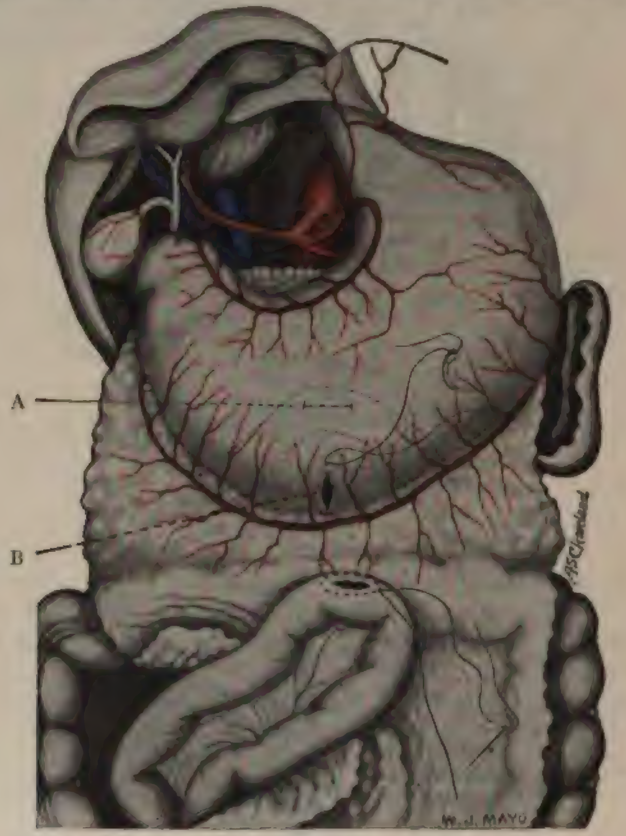


FIG. 458.—Anterior gastro-enterostomy. (*Mayo.*)
A. Wrong site for anastomosis. B. Proper site for anastomosis.

a point as can be reached. Clamp the cardiac orifice of the stomach. Divide the œsophagus between the clamps. Apply two clamps to the pyloric end of the stomach or to the duodenum and divide between them. Remove the stomach. Close the open end of the duodenum by a continuous through-and-through suture covered by a row of Lembert sutures, interrupted or continuous. Approximate a loop of jejunum to the open end of the œsophagus. Anastomose the œsophagus and the portion of gut selected by suture or by the Murphy button. Of course, if the open end of the duodenum can be

approximated to the œsophagus without undue tension, then these structures ought to be united. (Harvie, "Annals of Surg.," 1900, p. 344.) The technic of the operation is very similar to that of pylorectomy; in fact, the latter operation generally includes the removal of so much of the stomach that its designation is almost a misnomer.

Gastro-enterostomy, or anastomosis between the stomach and intestine, is indicated in cases of pyloric obstruction, gastric dilatation, and ulceration. According to the portion of intestine selected for anastomosis, the name "gastro-duodenostomy" or "gastro-jejunostomy" may be used.

FIG. 459.—Anterior gastro-enterostomy. (*Mayo.*)

According to whether the gut is united to the anterior or to the posterior wall of the stomach, the operation is designated "anterior" or "posterior gastro-enterostomy."

Wölfler's Operation.—Anterior Gastro-enterostomy.—The preparation of the patient is the same as in exploratory gastrotomy.

Step 1.—Open the abdomen by an incision in or near the middle line, between the umbilicus and the ensiform cartilage. The cut is about four inches long and may be enlarged by a transverse section of the rectus. This is very rarely necessary.

Step 2.—Expose the small intestine by pulling the omentum upwards and to the left. Find the jejunum by the method described on pages 369 and 371. Empty the loop of gut and apply clamps to keep it empty.

Step 3.—On the lowest possible point of the anterior wall of the stomach select a spot for the stomach opening (Fig. 458, A). Pull this portion of stomach and the loop of jejunum out of the belly and protect the cavity with gauze pads. Make an anastomosis between the stomach and the jejunum, using either sutures or the Murphy button (Fig. 459). The method of making the anastomosis is identical with that of entero-enterostomy (lateral anastomosis, page 406).

Step 4.—Cleanse the field of operation. Put aside all instruments which have touched the mucosa. Inspect the line of union, and if necessary reinforce it with a few Lembert sutures. If the point of union causes the intestine to kink sharply, this may be remedied by a few stitches uniting to the stomach a little more of the afferent or efferent portions of gut or of both.

Step 5.—Close the abdominal wound. The after-treatment is the same as for exploratory gastrotomy.

Posterior Gastro-enterostomy.—*v. Hacker's Operation.—Moynihan's Method.**

Step 1.—Expose the stomach by an incision ¾ inch to the right of the median line. Examine *the whole* stomach and duodenum. No matter what condition is apparent at the first glance, there may be something else present, *e.g.*, a trifid stomach, which it is necessary to recognize.

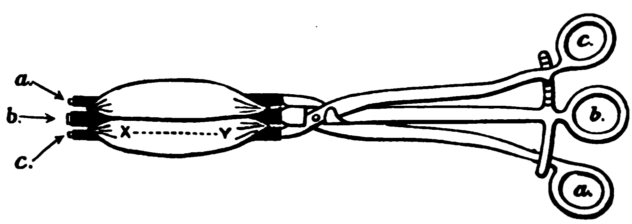


FIG. 460.—Roosevelt's clamp for gastro-enterostomy.

Step 2.—Lift the transverse colon and great omentum out of the abdomen and turn them up over the epigastrium. Expose the under surface of the transverse mesocolon. Choose a bloodless spot in this structure and tear through it. Have the assistant push the posterior wall of the stomach through this opening. Catch a fold of the protruded posterior wall of the stomach, three inches in length, in a gastro-enterostomy clamp, the blades of which have been covered with rubber tubing. Many clamps have been devised for gastro-enterostomy; those of Moynihan, Doyen, Hartmann and Harrington are each excellent. Instead of using two clamps it is much more convenient to employ a three-bladed instrument, such as the Roosevelt clamp (Fig. 460). The special advantage of the instrument is the steadiness with which the stomach and intestine are held together during the operation. When

* It is hardly necessary to remark that the Murphy button may be used in place of the sutures.

choosing a clamp do *not* select a light one; a powerful heavy instrument properly used is far more effective and less liable to cause injury to the patient and to the surgeon's temper than is one which is too delicate. Whatever clamp is used the points of the blades are liable to remain too far apart to retain efficiently the portion of stomach which should lie between them. To overcome this fault W. J. Mayo's first assistant allowed the protecting rubber tubing to project beyond the ends of the blade and then clamped the two portions of tubing together with a hemostat; this answered every purpose. Apply the clamp in such a way that the portion of stomach embraced by it extends from the greater curvature *obliquely upwards to the lesser curvature and towards the cardia.*

C. L. Gibson substitutes for the Roosevelt clamp three strips of wood bound together at each end by rubber bands. Ordinary wooden tongue depressors are excellent for the purpose.

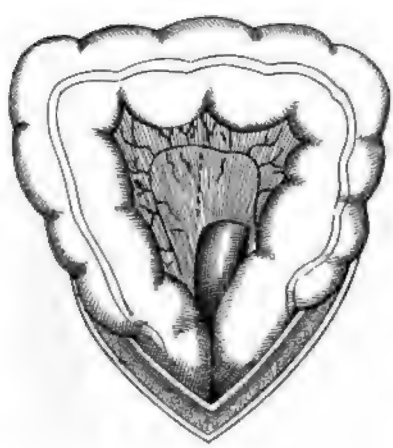


FIG. 461.—Exposure of beginning of jejunum.

Step 3.—When the transverse colon is pulled firmly upwards, the jejunum is at once seen coming through the opening in the transverse mesocolon (Fig. 461). This is the simplest means of finding that portion of the gut. Moynihan finds the duodeno-jejunal angle by sweeping the finger along the under surface of the root of the transverse mesocolon to the left of the spine. Bring the jejunum to the surface and clamp a portion of it, 9 inches from the angle, in a second gastro-enterostomy clamp. Surgeons are constantly lessening the length of the jejunal loop above the point of anastomosis. The distance of 9 inches has been almost classical, but it is now cut down by most operators to 4 or even 2 inches. A short proximal loop, so long as it does not drag the stomach upwards, is the best insurance against the "vicious circle."

Step 4.—Lay the two clamps side by side on the abdominal wall so that the portions of stomach and jejunum to be anastomosed are well outside the abdomen, embraced by the clamps. Protect the belly with pads, and make the anastomosis in exactly the same manner as in the case of a lateral enteroenterostomy (page 406). The length of the continuous Lembert suture should be at least two inches. In the stomach Mayo finds that a continuous silk or linen suture may give rise to late trouble. The thread may be partially sloughed into the viscus but much of it remains in the stomach wall acting as an irritant and causing ulceration. It is wise therefore to use interrupted or mattress sutures. The openings in the stomach and gut should be $1\frac{3}{4}$ inches, and, corresponding to this opening, a strip of gastric mucosa $\frac{1}{2}$ inch wide ought to be removed. Moynihan lays great stress on this excision of the mucosa as a prophylactic measure against subsequent contraction.

Step 5.—The edges of the rent in the mesocolon ought to be stitched to the stomach. Return the viscera to the abdomen and close the wound.

Mayo's "No Loop" Method.—The jejunum from its point of origin at the transverse mesocolon passes downwards, to the left and backwards, *i.e.*, it goes into the left kidney pouch below the splenic flexure of the colon. The duodeno-jejunal junction, *i.e.*, the origin of the jejunum, lies about 1½ inches to the left of the middle line, 1½ to 2 inches above the umbilicus, and its level

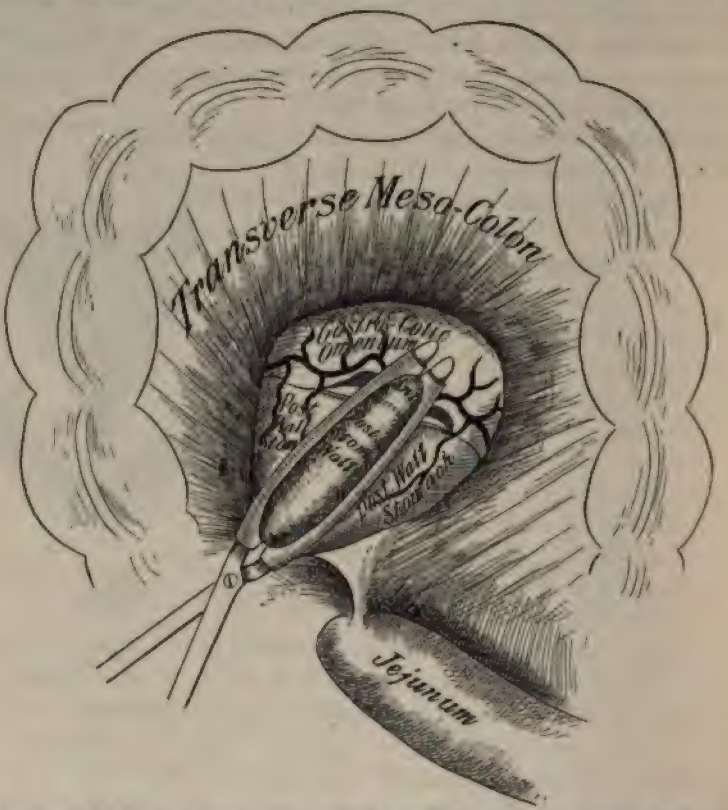


FIG. 462.—Colon and transverse mesocolon pulled upwards exposing jejunum.

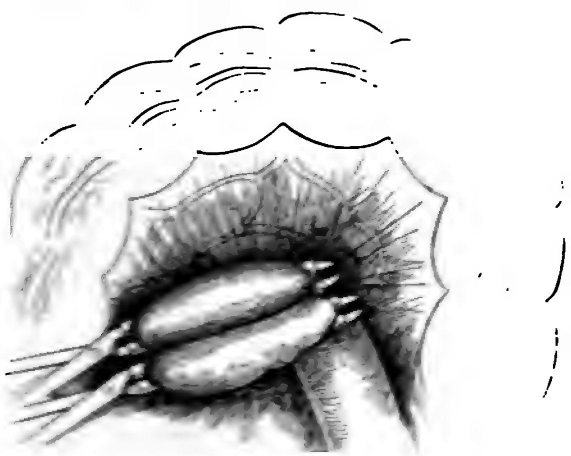
Exposure stomach through rent in mesocolon. Limited separation of gastro-colic omentum and gastro-epiploic vessels from lowest point of greater curvature of stomach permits exposure of small portion of anterior wall stomach. Fold of stomach in clamp consists of a small portion of the anterior and large portion of the posterior wall.

is only about 2 inches lower than that of the pylorus. From these anatomic arrangements it will be seen that if an anastomosis is made between the jejunum near its origin and the stomach in the Moynihan line, *i.e.*, making the gastric opening oblique *from below upwards towards the lesser curvature and towards the cardia*, the result must be a certain "kinking" of the jejunum above the anastomosis. This "kinking" has been found in a number of cases in which persistent vomiting compelled a secondary operation. A *slight* change in the position of the gastro-enterostomy fistula gave great improvement in the results obtained by the Mayos, J. C. Munro and others.

Step 1.—As in the preceding operation.

Step 2.—Draw the transverse colon out of the wound and by pulling upwards and to the right, bring so much of the mesocolon with it that the jejunum becomes visible. Pick up the jejunum about 3 inches from the origin. Note the fold of peritoneum passing from the jejunal origin to the transverse mesocolon: near where this fold joins the mesocolon is the best place in which to tear a hole in the mesocolon and expose the posterior surface of the stomach (Fig. 462).

Sometimes this fold of peritoneum extends so far down the jejunum that an anastomosis between the stomach and the jejunum distal to the fold leaves sufficient gut above the anastomosis to form a loop. When such is the case divide the fold of peritoneum, as the avoidance of any loop of gut above the anastomosis is of prime importance.



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and jejunum thoroughly shut off from contamination the abdominal cavity and the abdominal wound.

Sinclair White and some others have given up the use of clamps because of fatal hemorrhage having taken place from the suture line after their removal. If the following method is used there is little if any danger of bleeding, certainly the danger from this source is less than the danger to be apprehended from soiling of the field of operation and from loss of blood during the operation in weak patients when the clamps are not used. When hemorrhage takes place it is from the posterior suture line of the gastro-jejunostomy.

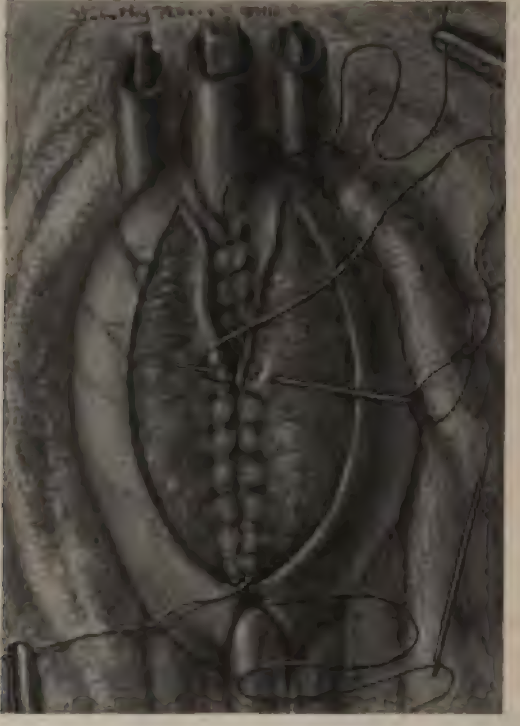


FIG. 464.—Gastro-jejunostomy made with three sutures on posterior line because of occasional hemorrhage into the gastro-intestinal tract after clamps are removed. Drawing shows catgut button-hole suture applied posteriorly without opening mucous membrane. (*Mayo.*)

Unite the stomach to the jejunum for a distance of about 2½ inches by a row of mattress sutures exactly as in intestinal lateral anastomosis (posterior serous suture). Make an incision parallel to and shorter than the posterior serous suture, through all the coats of the stomach except the mucosa. The mucosa now pouts up into the wound. Make a corresponding incision in the jejunum. Introduce a button-hole or locking continuous suture of chromicized or formalinized catgut, including in each stitch (a) a bite of the unopened gastric mucosa, (b) the other coats of the stomach, (c) the serous and muscular

coats of the jejunum, (d) a bite of the unopened jejunal mucosa. This line of suture unites the posterior edges of the stomach wound to the corresponding wound in the jejunum (Fig. 464). Incise the mucosa of the stomach and jejunum and with the same needle and catgut suture used in the preceding line of suture unite by a whip stitch the mucous coats of the stomach and jejunum (Fig. 465). With the same suture unite the anterior edges of the stomach and intestinal wounds by means of a Connel stitch (through all the coats of the organs) or of a through-and-through buttonhole (or locking stitch) exactly as

FIG. 465.—Gastro-jejunostomy made with three sutures on posterior line because of occasional hemorrhage into the gastro-intestinal tract after clamps are removed. Drawing shows mucous membrane opened. Running suture of catgut to bring mucous coats of stomach and jejunum together. (*Mayo.*)

in lateral anastomosis. Remove the intestinal clamps. Complete the serous suture as in lateral anastomosis. Discard all instruments used in making the anastomosis; they are soiled. Cleanse the operative field. Remove the gauze pads. By taking hold of both ends of the narrow gauze pad or strip placed behind the site of anastomosis and manipulating it properly it is easy to bring into view the whole posterior surface of the anastomosis for inspection. *If necessary* introduce one or more Lembert or Gould sutures to assure safe union. The gastro-enterostomy is complete.

Step 6.—Unless the opening in the gastro-colic omentum is rendered secure hernia of the small intestine or omentum through it into the lesser peritoneal cavity can take place and cause disaster.

With three or four sutures unite the lower peritoneal surface of the mesocolon, a quarter of an inch away from the rent, to the suture line and tuck in the torn edges of the rent so as to avoid adhesions. If the mesocolon is *fat* attach the torn margins of the opening to the stomach (instead of to the suture line) so as to avoid the formation of a collar-like band at the anastomosis (Mayo).

Maury's Method.—Maury's operation is essentially a modification of McGraw's, but is accomplished with materials always at hand.

Step 1, 2, 3 are the same as in v. Hacker's operation, except that no clamps are used.

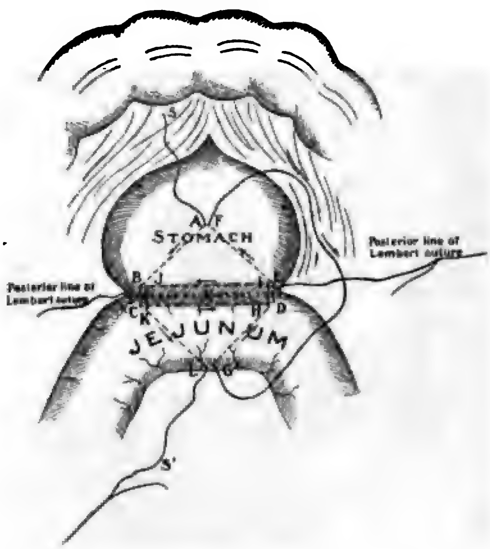


Fig. 466.—Maury's method of gastro-enterostomy.

Step 4.—Lay the chosen segment of jejunum against the lower portion of the stomach. Insert a row of Lembert sutures, 90 degrees distant from the mesentery, and so unite the intestine to the stomach. Leave the ends of this the posterior line of Lembert sutures, long.

Step 5.—Thread a straight, round needle (darning-needle), 3 inches long, with very strong twine. Introduce the needle into the stomach at the point A (Fig. 466). Be sure the mucosa is penetrated. The point A should be near the vessels of the greater curvature, and the distance between A and X (the mid-point of the line of Lembert sutures) should be less than the diameter of the gut. Bring the needle out from the stomach at the point B, 1/4 inch from the beginning of the Lembert suture. Make the needle traverse the intestine from C to D and the stomach from E to F. The points D and E must be 1/4 inch from the ends of the Lembert suture.

Make the same needle and thread traverse the gut from G to H, the stomach from I to J, and lastly the gut from K to L.

This apparently complicated but really simple series of stitches forms two equal triangles the apices of which (A F, L G) are equidistant from the middle of the base (X).

Step 6.—Tie the ends of the twine (S, S′) together very tightly. This is of great importance, as necrosis of the included tissues is essential.

Step 7.—Continue the line of Lembert sutures already in place completely around the site of the twine. The tying of the twine will have thrown the surface of the gut into a number of radiating folds, therefore to obliterate these while completing the Lembert sutures insert the stitches as much as possible at the bottom of these sulci.

Mikulicz-Czerny Operation.—Mikulicz and Czerny perform a gastro-jejunostomy based on two simple principles: "First, the origin of the jejunum lies above the greater curvature of the stomach. After opening the transverse mesocolon and fastening it to the posterior wall of the stomach, the upper three

FIG. 467.

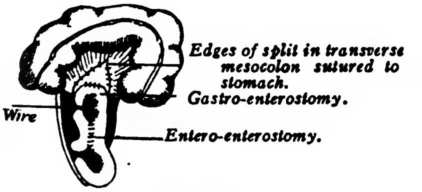


FIG. 468.

or four inches of the jejunum lie directly in contact with the gastric wall, hanging perpendicularly with its free border (opposite the mesentery) facing the stomach-wall. Second, by making a transverse incision in the jejunum three or four inches from its origin and an incision close to the greater curvature of the stomach, a suture anastomosis is made in which the stomach is drained at the lowest point without the possibility of kinking the intestine."

Czerny was the first to carry out this operation, but used the Murphy button. Petersen notes that unless the anastomosis is exceedingly close to the origin of the jejunum obstruction may take place. Petersen is enthusiastic over the method. Experience in America has not been favorable to the Mikulicz-Czerny operation; a reverse vicious circle seems to have been established in too many cases, *i.e.*, material—*e.g.*, bile, etc.—seems to pass along the duodenum, enter the jejunum, and then pass into the stomach. In one case operated on by the writer there was an unusual and annoying amount of vomiting for some weeks after the operation. Other surgeons have had worse experiences.

Roux's Operation; Operation en Y.—*Steps* 1, 2, and 3, as in posterior gastro-enterostomy.

Step 4.—Having chosen the appropriate portion of jejunum, empty it of its contents, apply two clamps, and completely divide the gut between them. Anastomose with suture or button the open end of the lower segment of gut to the posterior wall of the stomach (Fig. 469). Anastomose the open end of the proximal or duodenal segment of the gut to the side of the lower segment of gut, a few inches below the site of the gastro-enterostomy.

Many surgeons, to avoid the possibility of the formation of a "vicious circle" (page 379), complete the gastro-enterostomy by forming an anastomosis between the afferent and efferent loops of jejunum at a point 6 inches lower down the gut (Fig. 433). Fowler, to make assurance doubly sure, encircled the afferent loop, between the two points of anastomosis, with a silver wire thread to obliterate its lumen; the same object may be attained by a purse-string suture of silk around the gut at the same place.

FIG. 469.—Roux's gastroenterostomy. (*Monod and Vanverts.*)

These methods of endeavoring to obliterate the gut lumen have proven unreliable, at least in the case of the pylorus, as the sutures or ligatures become extruded into the gut which soon assumes its former size. Lambotte finds that if the ligature is tied tightly enough to obstruct but not tightly enough to strangulate or cause pressure, then the desired occlusion is attained and maintained. Brewer uses strips of aluminum instead of threads.

For the same purpose and also to prevent the passage of food into the duodenum after gastro-enterostomy for duodenal ulcer various methods of pyloric exclusion have been practised. Operative closure of the stomach or duodenum above the ulcer is not indicated when there is sufficient stenosis due to the ulceration.

Bier writes: "pyloric occlusion ought never to be omitted in cases of gastro-jejunostomy when well-marked stenosis is absent and when the operation has been performed for very painful or bleeding ulcers of the pylorus or particularly of the duodenum."

Duodenal ulcers which bleed freely or which threaten perforation should be buried by means of sutures or, if feasible and not too dangerous, the ulcer ought to be excised.

Methods of Pyloric Exclusion.—1. *Doyen and v. Eiselsberg's Method.*—Choose a place to the oral side of the ulcer and in healthy tissue. Make an opening, close to the lesser curvature, through the lesser omentum and a corresponding opening close to the greater curvature, through the gastro-colic omentum. Apply two clamps to the stomach. Place a strip of gauze behind the clamped portion of the stomach. Divide the stomach between the clamps with a thermo-

cautery. Close each stump by a row of through-and-through sutures buried by a row of serous sutures.

2. *Bartlett's Method* (Journ. A. M. A., Aug. 15, 1914).—Choose a place on the oral side of the ulcer (whether of the duodenum, pylorus or pyloric antrum). Make an opening through the great omentum close to the greater curvature. Apply two crushing clamps to two-thirds of the diameter of the stomach and cut between them. Close the wound with through-and-through sutures. Bury this line of sutures by serous sutures (Fig. 470).

3. *Bier's Method.*—Well to the oral side of the ulcer and on healthy tissue apply a crushing clamp, *e.g.*, Payr's to the stomach. Remove the clamp and replace it by a strong ligature. Bury the ligature with a row of serous sutures (Fig. 471).

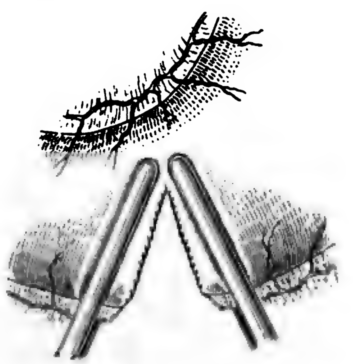


FIG. 470.—Bartlett's method.

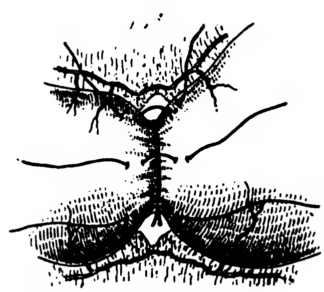


FIG. 471.—Bier's method.

4. *Author's Method.*—Ligate and cut away a sufficient tag of great omentum. Apply this tag like a ligature tightly around the pylorus. Bury the implant by a row of serous sutures. A strip of fascia may be used in the same fashion (Wilms).

5. *C. H. Mayo's Method.*—Introduce a closed hemostat through the great omentum close to the greater curvature, pass it upwards behind the stomach and make its point seize the lesser omentum some distance above the lesser curvature. Pull the lesser omentum behind the stomach out through the perforated great omentum and then upwards in front of the stomach to be sutured to the rest of the lesser omentum.

6. *Brewer* (Surg., Gyn., Obst., Feb. 1914).—Pass a band of aluminum about 5 cm. long by 1 cm. wide around the pylorus and compress it sufficiently to obliterate the lumen without interfering with nutrition.

7. *Biondi's Method* (Figs. 472 to 477).—In the middle of the anterior surface of the antrum pylori make an incision about 6–10 cm. long in the long axis of the stomach and duodenum. Most of this incision should be on the gastric side of the pylorus. Cut through the peritoneum and the muscular and submucous tunics but leave the mucosa intact. Shell a segment of the mucosa as a tube out of its submucous bed and doubly ligate and divide this tube at each end. Close the wound in the serous and muscular tunics. Of

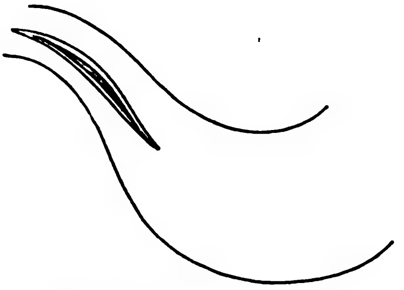


FIG. 472.—(*Porta, J. de Chir.*)

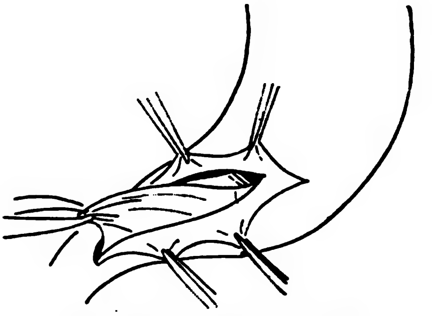


FIG. 473.—(*Porta, J. de Chir.*)

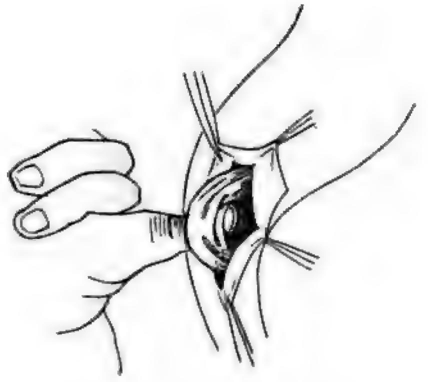


FIG. 474.—(*Porta, J. de Chir.*)

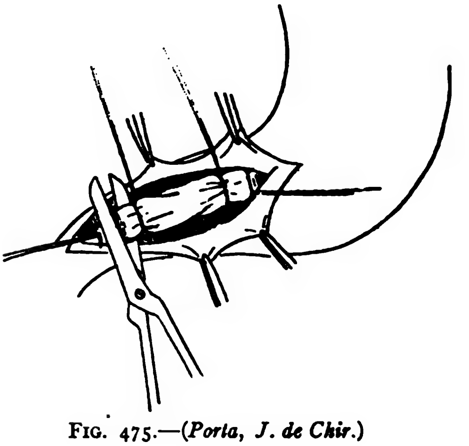


FIG. 475.—(*Porta, J. de Chir.*)

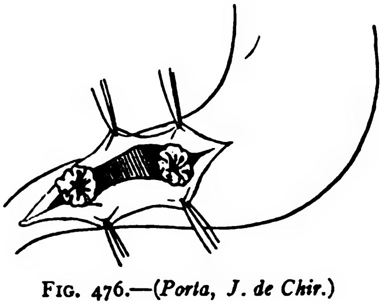


FIG. 476.—(*Porta, J. de Chir.*)

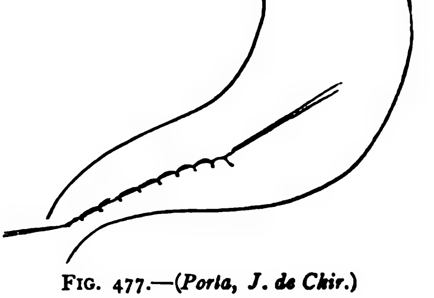


FIG. 477.—(*Porta, J. de Chir.*)

these methods, section of the pylorus (Doyen, v. Eiselsberg, Bartlett) is the most efficacious and least safe.

Biondi's operation seems good. Probably the methods devised by the author and Bier are the simplest and *least* efficacious.

Instead of using these methods of pyloric occlusion, some surgeons having supplemented the gastroenterostomy by making a lateral anastomosis between the afferent and efferent loops of jejunum completely divide the afferent loop between the two points of anastomosis and close the open ends of the gut by purse-string sutures (Fig. 467). This method has all the advantages of Roux's operation, but does not interfere to the same extent with the mesentery. It is certain that in the hands of most surgeons, the dangers of the vicious circle are less than those incident to the complicated methods devised for its avoidance.

Occlusion of the duodenum must never be practised if the McGraw elastic ligature or Maury's triangular string method have been employed in making the gastro-enterostomy. By these methods it takes about seventy-two hours to establish gastric drainage. Maury's experiments ("Surg., Gyn. and Obstetrics, May, 1906) clearly show that if, in dogs, the gut is divided and both ends closed at any point nearer to the pylorus than 14 inches (35 cm.) and the distal segment is united to the stomach by the ligature method, the dog will promptly die with symptoms of tetany. The death in these cases seems to be from some form of auto-intoxication due to the want of gastric drainage, because when a fistula is established between the stomach and the distal portion of gut at the time of the operation, no such catastrophe arises.

The Vicious Circle.—When the afferent portion of gut is so placed that stomach contents pass into it instead of into the efferent loop, grave consequences are liable to ensue, and to the condition the name "vicious circle" has been given. Many precautions have been taken to avoid this accident, but only the more important and effectual will be mentioned. The accident seems to be very rare after posterior gastro-enterostomy. Roux's operation, "en Y," almost precludes its possibility, and the various methods of adding an entero-enterostomy to the gastro-enterostomy give safety in regard to the vicious circle, but of course add distinctly to the gravity of the operative procedure. No symptoms of the vicious circle seem to have followed the performance of the [illegible] operation.

Peptic Gastro-jejunal or Jejunal Ulcer.—Braun and Mikulicz have shown that the duodenum and upper segments of the jejunum are more resistant to the [illegible] action of the gastric juice than are the lower segments of gut. In posterior gastro-enterostomy the portion of gut opened [illegible] inches from the [illegible] Several [illegible]

[illegible]

in the serous coats) in gastro-enterostomy occasionally causes ulceration at the site of anastomosis.

If jejunal ulcer is diagnosed some time after the operation of gastro-enterostomy and general treatment has proved useless the abdomen must be opened again and the anastomosis and neighboring jejunum examined.

Mayo-Robson ("Brit. Med. Journ.," Jan. 6, 1912) advises as follows:

1. There is ulceration at the anastomosis or in the jejunum. The original pyloric or duodenal ulcer has healed (without stenosis). Detach the jejunum from the stomach. Excise the ulcer. Close the openings in the stomach and jejunum. If the gastro-jejunal ulcer is extensive excise that segment of gut. Restore the continuity of the gut by end-to-end anastomosis. Close the opening in the stomach.

2. The pyloric or duodenal ulcer in healing has caused stenosis. Either choose a new site for posterior anastomosis or perform Roux's anterior gastro-enterostomy, after excising the ulcer or the ulcerated segment of jejunum.

3. The anastomotic opening is healthy; the jejunum alone is affected. Excise the ulcer, repair the bowel, do not interfere with the anastomosis.

4. If the patient is profoundly ill and unable to bear a prolonged operation perform jejunostomy, so that he may be fed and the ulcer, whether in the jejunum, stomach or duodenum, can be given complete rest until healing is effected.

Choice of Method by Which to Effect the Anastomosis.—1. *Suture.*—In the hands of experts undoubtedly the method by suture is the most satisfactory. Few surgeons, however, could equal Moynihan's record of a posterior gastro-enterostomy (sutures) completed in seventeen minutes. In cases where time is not the prime consideration probably this method is the best, but in the exhausted and feeble the junior surgeon will find the Murphy button and the McGraw elastic ligature time-saving contrivances.

2. *Murphy's Button.*—(Method of use, see page 408.) Many surgeons use this instrument in all their anastomoses. It is not quite so safe and efficient as the suture, except in respect to the saving of time. Mikulicz reserves the use of the button for cases of malignancy. Moynihan has given it up definitely as unnecessary and hazardous. Ochsner gives a useful warning against its employment in scar tissue. In the hands of the *average* the button holds its own as a time-saving and hence a life-saving instrument.

3. *McGraw's Elastic Ligature.*—(Method of use, page 410.) This ingenious method occupies a place midway between the suture method and the button. It is more rapid than the former and slower than the latter, but is safe. In the hands of McGraw, Willy Meyer, and others it has given great satisfaction. The principal disadvantage to it is that in emergency one will almost never have the proper rubber ligature at hand ready for use.

In order to give nourishment early after gastro-enterostomy and at the same time avoid irritating the stomach with food A. Hammestahr "(Centralblatt f. Chir.," June 6, 1903) uses Rutkowsky's method of combining a gastro-enterostomy and a gastrostomy. A catheter is introduced through the gastric fistula into the jejunum and kept in place until the stomach is in condition to take

care of food. Feeding is carried on through the catheter. On removal of the catheter the fistula quickly closes. The method seems an unnecessary complication.

Operation for "Hour-glass" Stomach.—The figures (478 to 483*) sufficiently explain the methods of operating on hour-glass contraction of the stomach. In Fig. 478 an anastomosis is made between the two gastric pouches, at the points X and Y. In Fig. 481 the cardiac pouch, being large and dependent, is united to the jejunum. In Figs. 479 and 480 an incision is made through

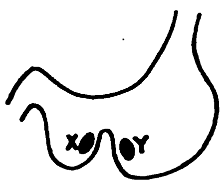


FIG. 478.

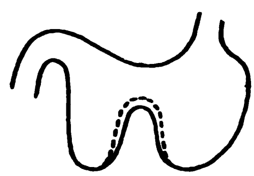


FIG. 479.

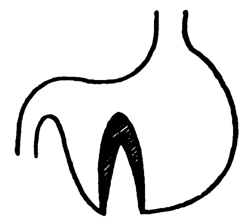


FIG. 480.

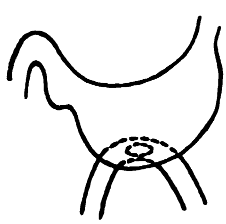


FIG. 481.

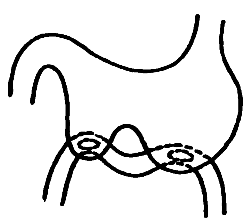


FIG. 482.

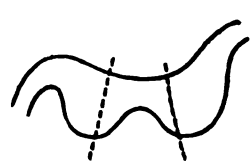


FIG. 483.

FIGS. 478 TO 483.—Hour-glass stomach. (*Moynihan.*)

the lowest part of the constriction and when the edges of the cardiac side are united to those of the pyloric side, the normal shape of the stomach is more or less restored. The principle of this operation is identical with that of Mikulicz's pyloroplasty.

Note that pyloric stenosis may accompany hour-glass stomach. When this is so, the condition must be corrected or a gastro-enterostomy established.

Congenital Pyloric Obstruction.—Cases of congenital pyloric obstruction which do not promptly yield to medical treatment must be subjected to operation. For the author a posterior gastro-enterostomy (very light clamps are used) is the operation of choice.

Scudder (Annals of Surg., lix, page 257, 1914) has performed posterior gastro-enterostomy seventeen times in congenital stenosis with four deaths. His only fatalities were in greatly emaciated patients. The following are his statistics.

* Figs. 478 to 483 are taken from Moynihan's work, but Figs. 479 and 480 have been modified.

TABULATION OF THE CASES OF PYLORIC STENOSIS

No.	Age at operation	Duration symptoms	Time since operation	Post-operative X-rays	
1	14 days	14 days	8 years	5 years, 1910.	Food through stoma.
2	24 days	24 days	8 years	8 years, 1913.	Food through stoma.
3	22 days	6 days	7 years	7 years, 1913.	Food through stoma.
4	25 days	11 days	5 years	5 years, 1913.	Food through stoma.
5	7 weeks, 5 days	3 weeks	5 years	5 years, 1913.	Food through stoma.
6	5 weeks	2 weeks	4 years	1 year, 1910.	Food through stoma.
7	13 weeks, 4 days	11 days	4 years		
8	4 weeks, 4 days	2 weeks, 2 days	3 years		
9	5 months	5 months	3 years	3 years, 1913.	Food through stoma.
10	5 weeks, 4 days	4 days	3 years	3 years, 1913.	Food through stoma.
11	7 weeks	5 weeks			
12	4 weeks	4 weeks			
13	6 weeks	3 weeks	Died		
14	11 weeks	8 weeks	2 years		
15	6 weeks	2 weeks	Died		
16	14 days	14 days	1 year	1 year, 1913.	Food through stoma.
17	5 weeks	2 weeks	Died		

Downes' statistics (Journ. A. M. A., 27, June, 1914) are very similar to those of Scudder: posterior gastro-enterostomy in twenty-one cases with seven deaths (three deaths from collapse in very feeble subjects; one from hemorrhage due to puncture of the round ligament during suture of the abdominal wound; one from peritonitis; two from unknown causes. An eighth patient died four

FIG. 484.—Pyloric stenosis. (*Nicoll, "Glasgow Med. Journ."*)

days after leaving hospital from acute gastro-enteritis). In cases where great haste is demanded Downes advises partial pyloroplasty by incision through the stenosed pylorus down to, but not through the mucosa.

In cases of congenital obstruction of the pylorus the Finney operation may be indicated, but Jas. H. Nicoll's results have been so excellent that his methods

require weighty consideration. Nicoll ("Glasgow Med. Journ.," April, 1906) divulsed the pylorus in seven cases, with cure in five and no relief in two. Because of the failures he concluded divulsion plus gastro-enterostomy was more ideal *but* the mortality of this in infants is 50 per cent. or more. Nicoll devised a plastic operation which he performed on six consecutive cases with one death and five cures. The operation may be done either with or without dividing the mucosa.

Nicoll's Pyloroplasty.—Method A.—Step 1.—Expose the pyloric region. Apply rubber-covered clamps to the stomach and duodenum.

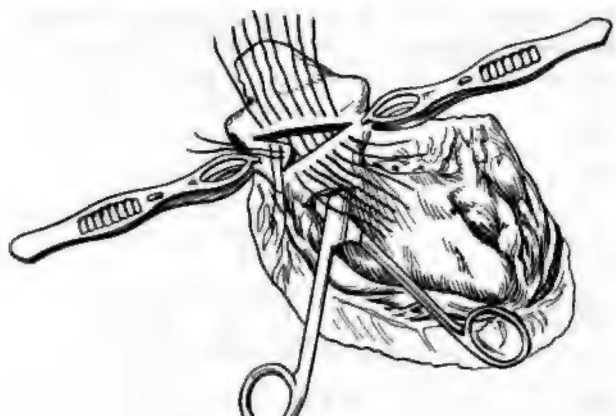


FIG. 485.—Pyloric stenosis. (*Nicoll, "Glasgow Med. Jour."*)

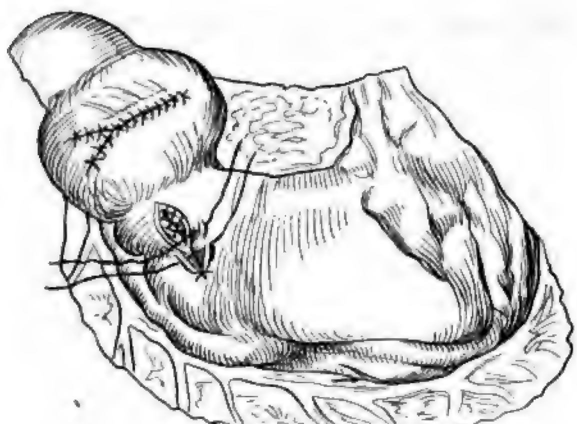


FIG. 486.—Pyloric stenosis. (*Nicoll, "Glasgow Med. Jour."*)

Step 2.—Puncture the stomach. Through the puncture pass a closed sinus forceps or clamp into the stomach and so through the pylorus. Using the forceps as a glove stretcher dilate the pylorus (Figs. 484 and 485).

Step 3.—Make a Λ incision down to but not through the mucosa (Fig. 485). Convert the Λ into a ⅄ and suture (Fig. 485). Close the puncture in the stomach (Fig. 486).

Method B.—Omit puncturing the stomach. Make the Λ incision through the whole intestinal wall (mucosa included). Through the incision pass the divulsing forceps and divulse. Convert the Λ into a λ by the usual two rows of intestinal sutures.

In the Children's Hospital, Boston, Charles G. Mixter reports that the Webb-Rammstedt operation has given good results:

From beside the umbilicus make a 1½ inch incision upwards through the right rectus muscle. Deliver the pylorus and rotate its superior surface forwards. Incise the tumor longitudinally, from end to end, through the bloodless area above the limits of the pyloric vein. Carry the incision down to, but not into, the submucosa which shows a white glistening membrane. With blunt scissors separate the musculosa from the submucosa for about ¼ inch on each side of the wound. Gas now escapes from the stomach through the pylorus to the duodenum and the distended stomach collapses. (If there is any doubt as to the patency of the pylorus open the stomach and pass dilating forceps through the constriction. Close the wound in the stomach.)

Replace the pylorus in the abdomen. Do *not* suture the wound in the pylorus. Close the abdomen.

Out of 8 cases operated upon one died from inanition.

OPERATIONS UPON THE PYLORUS

Pylorodiosis.—When pyloric stenosis is due to spasm or hypertrophy of the sphincter, this operation may be indicated, but as it has proved to be by no means safe and recurrence of the trouble is frequent after its performance, and as other methods give more certain results, the operation is not much in favor.

Hahn's Method of Performing Pylorodiosis.—Expose the stomach by an incision to the right of the middle line. With the finger invaginate a portion of the anterior wall of the stomach and push it, along with the finger, through the pylorus. When the pylorus is sufficiently dilated, close the abdominal wound.

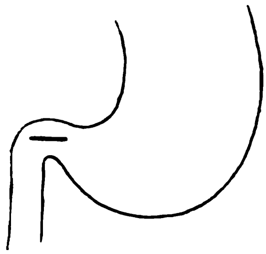
Loreta's Method.—Expose the pylorus. Incise the stomach near the pylorus. Through the stomach-wound pass the forefinger of each hand into the pylorus and forcibly dilate it. Instead of the fingers bougies may be used.

Pyloroplasty (Heineke-Mikulicz operation) is indicated in cases of spasmodic or cicatricial pyloric stenosis.

Step 1.—Expose the stomach near the pylorus by a vertical incision. Explore the *whole* stomach lest coexistent disease be overlooked. Separate adhesions which may exist around the pylorus. If possible, pull the pylorus out of the abdomen. Protect the peritoneal cavity with gauze pads. Clamp the stomach and duodenum with appropriate instruments (*e.g.*, Doyen's clamps).

Step 2.—Make a small opening into the stomach near the stenosis. Pass a finger or an instrument through the pylorus as a guide. It is generally advised to make a longitudinal incision through the *anterior* wall of the pylorus, completely dividing the stricture, and then to convert the longitudinal into a trans-

me wound and close it by sutures (Figs. 487, 488). But, as Mikulicz re-arked "that is not the way we do it." According to him, the longitudinal cision is made on the under surface of the stenosed pylorus (Fig. 489, A, B,). Having made this inferior incision, unite the posterior edges of the wound at by a continuous or interrupted row of Lembert sutures, and then by a row f sutures embracing the whole thickness of the walls. Continue the latter row



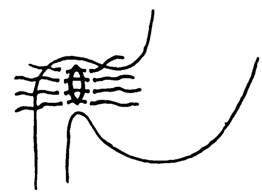
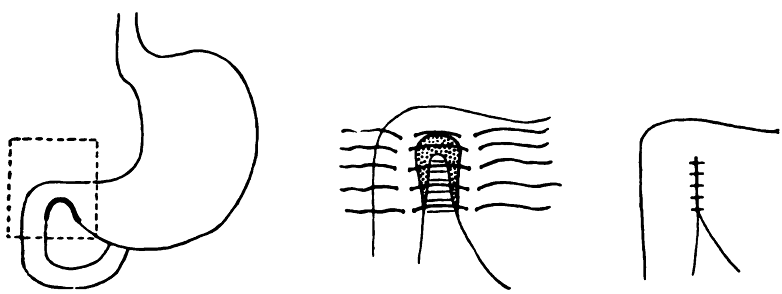


FIG. 487. FIG. 488.
FIGS. 487 AND 488.—Pyloroplasty. Wrong method.

as to close the anterior edges of the wound, and complete the union by in-ting an anterior row of Lembert sutures. It is very evident that this method ssesses all the good qualities of that usually described, and has the great vantage, in addition, that it lowers the level of the exit of the stomach.

Finney's Operation.—Finney's operation is a most valuable contribution to rgery and in many cases it is a desirable substitute for gastro-enterostomy. hen as a result of ulceration there is a spastic condition of the pylorus the rest :ured through gastro-enterostomy gives a very brilliant immediate result,



A B C
FIG. 489.—Pyloroplasty. Correct Method.

as spasm abates food once more resumes its normal route through the py-s, the artificial opening is liable to contract, and recurrence of the trouble requent. In such cases Finney's method is of great service. The presence nany adhesions is stated to be a contra-indication to the operation but it exactly in such a case, where adhesions impeded gastro-enterostomy, t Finney noticed how closely and conveniently the duodenum and stomach together and at once proceeded to unite them. Many variations in tech-ue have been devised but the principles of all are the same and the author as

will take the liberty of describing the operation as he has done it himself.* Clamps may or may not be used.

The Operation.—The abdomen having been opened and the pylorus with the adjacent portions of the stomach and duodenum, if possible, pulled out of the abdominal wound, protect the peritoneum thoroughly with gauze packs.

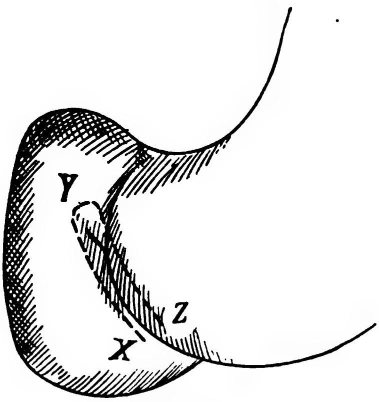


FIG. 490.

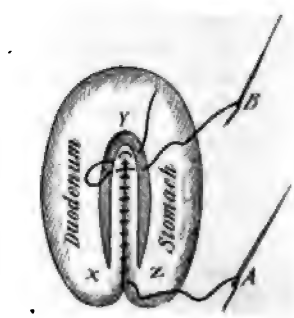


FIG. 491.

FIGS. 490 AND 491.—Finney's operation.

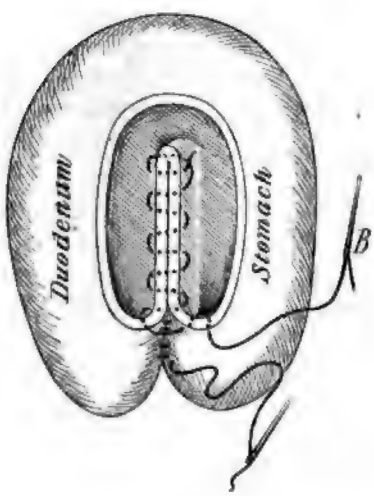


FIG. 492.

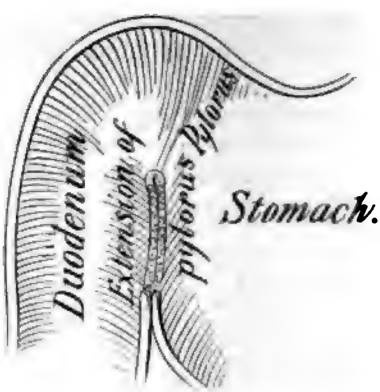


FIG. 493.

FIGS. 492 AND 493.—Finney's operation.

Step 1.—Unite the adjacent surfaces of stomach and duodenum by a continuous Lembert suture (A, Fig. 491). (Posterior line of serous suture.)

Step 2.—Make the ∩-shaped incision XYZ (Figs. 490 and 491), opening both the stomach and duodenum and dividing the pylorus.

Step 3.—Unite the two posterior edges of the ∩ incision by means of Connell sutures or by a through-and-through whipping-stitch (Figs. 491 and 492).

* This account of the operation was submitted to Finney and met his approval.

At this stage scar tissue or active ulcers present in the anterior wall of the stomach or duodenum may be excised through the incision. Ulcers in the posterior wall may have their overhanging mucous edges trimmed and their dense fibrous base incised, care being taken to avoid perforation and to stop all bleeding by ligature or suture. With the same suture unite the two anterior edges of the ∩ incision (Fig. 492).

Step 4.—Continue the Lembert suture introduced in Step 1, around the anterior surface of the anastomosis (anterior line of serous suture) and bury from sight the stitches introduced in Step 3.

Fig. 493 shows in section the result of the operation. An examination of 78 cases seen from one to twelve years after operation showed an average of 93.8 per cent. satisfactory results. (Finney, Surg., Gyn., Obst., March, 1914.)

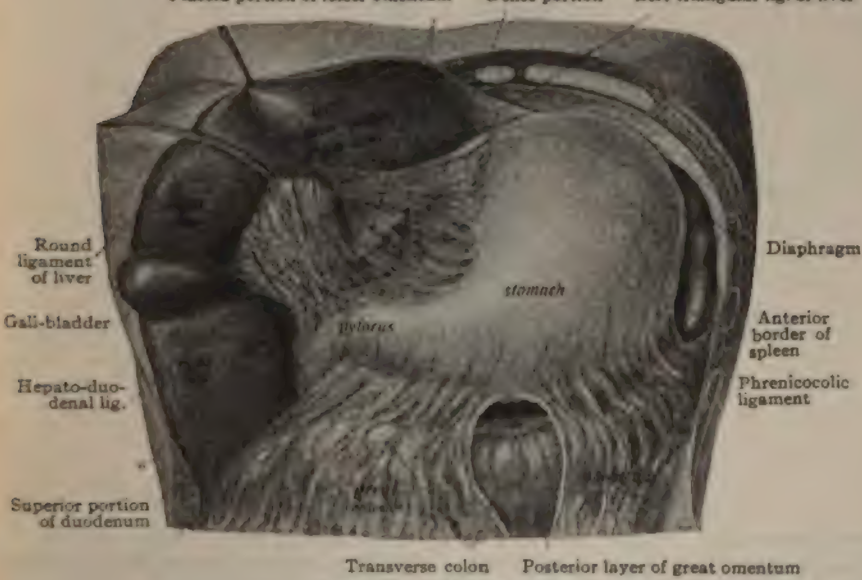


FIG. 494. (*Sobotta.*)

If it is difficult to lay the duodenum along side of the stomach without tension it is easy to make a vertial incision through the parietal peritoneum two finger-breadths to the right of and parallel to the descending portion of the duodenum (Kocher). The fingers introduced through the wound in the peritoneum easily separate the duodenum (and with it, if necessary, the head of the pancreas) from the vertebral column, vena cava and aorta and so mobilize the gut that Finney's operation becomes easy.

How extensive ought one to make the new opening between the stomach and duodenum? Finney makes a very extensive opening and finds it satisfactory. The Mayos think the lower end of the new opening ought not to reach as low as the ampulla of Vater.

Pylorectomy.—This operation is almost always supplemented by a partial gastrectomy. The indications for its performance are usually malignant disease or pyloric ulcer and its sequelæ. Before operating on the stomach especially for cancer, it is of great importance to have a good working knowledge of the anatomy of the region, a knowledge which the standard text-books on anatomy are careful *not* to give.

The gastro-hepatic or lesser omentum may be divided into three parts: (*a*) a thick, strong portion running from the liver to the cardiac end of the lesser curvature and part of the œsophagus (gastro-hepatic ligament), (*b*) a central or thin, often translucent portion, and (*c*) a thick, strong portion at and

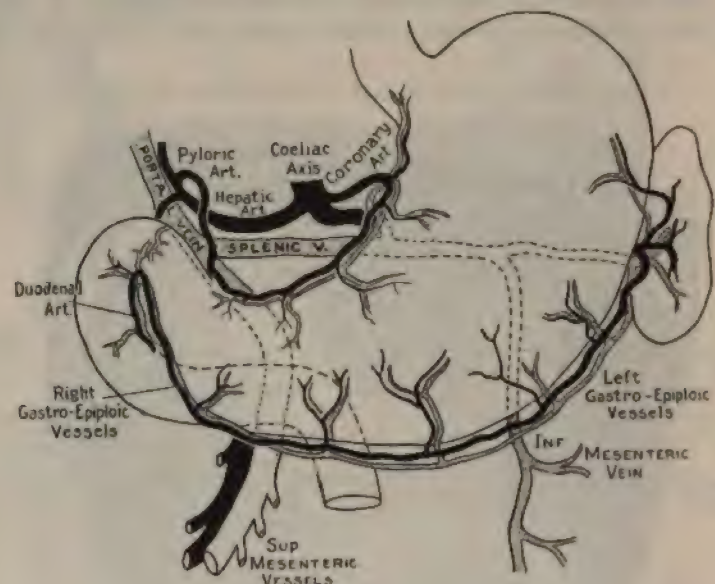


Fig. 495.

near the right end of the omentum and often named the hepato-duodenal ligament as it runs from the liver to the duodenum (Fig. 494). The hepato-duodenal ligament is subject to variations which may be understood by the descriptive names given to it, *e.g.*, cystico-colic ligament; cystico-duodenal ligament; cystico-hepato-duodeno-colo-epiploic ligament (Tuffier and Jeanne, "Revue de Gyn. et Chir. Abdom.", Jan., 1912). If a hole is torn through the thin or median portion of the gastro-hepatic omentum, the lesser peritoneal cavity (antrum bursæ omentalis) is entered. Behind the peritoneum forming the posterior wall of the lesser cavity lies the cœliac axis which divides into three branches all of which are, to begin with, retro-peritoneal (Fig. 495). These branches are (*a*) the splenic which passes to the left to reach the spleen. During much of its course the splenic artery remains retro-peritoneal lying above and behind the pancreas. Before reaching the spleen the vessel gives off the left gastro-epiploic artery which runs along the greater curvature of the stomach in

ro-colic or great omentum to anastomose with the gastro-duodenal artery.
hepatic artery which passes retro-peritoneally to the right along the order of the pancreas for a short distance when it enters a fold of per- (hepatic fold) through which it reaches the lesser omentum (hepato- l ligament). In its course the hepatic artery gives off (1) the pyloric which enters the lesser omentum and runs to the left along the lesser re of the stomach to the anastomose with the coronary artery, (2) the uodenal which runs downwards between the pancreas and the duodenum er giving off a duodenal branch, passes in the gastro-colic omentum e greater curvature of the stomach to anastomose with the left gastro-

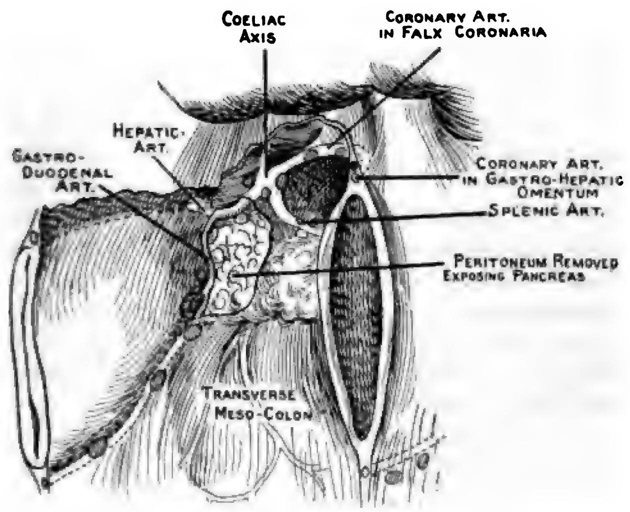


Fig. 496.

The coronary or gastric artery which passes into the falx coronaria or pancreatic fold (Fig. 496) and through it reaches the lesser omentum e cardiac orifice of the stomach where, after sending a branch towards the gus, it runs along the lesser curvature of the stomach to anastomose with oric artery.

folds of peritoneum which have been mentioned (gastrohepatic fold, ar to the arteries a relation more or less similar to that of the mesentery ntestine.

he right portion of the lesser omentum (hepato-duodenal ligament) lie t to right the hepatic artery, the portal vein and the bile ducts. If an is made through the anterior layer of peritoneum forming the lesser m close to the pylorus it is easy to mobilize the pylorus and the gastric the duodenum without injuring the gastro-duodenal vessels or the n bile duct.

lymphatics of the stomach have their ultimate roots in two systems:

1. Under the epithelium and surrounding the gland tubules there is a very rich plexus of lymphatic capillaries. From this plexus short vessels penetrate the muscularis mucosæ and join another rich plexus in the submucosa. In turn, the submucosal plexus drains through vessels penetrating perpendicularly the muscular tunics, into the subserous plexus.

2. Among the fibres of the musculature of the stomach another set of lymphatics arises and drains into the subserous plexus. There is free anastomosis between the lymphatics perforating the musculosa and those originating in the musculosa. The lymphatics of the mucosa and submucosa are truly capillaries—*i.e.*, they are endothelial tubes, are innocent of fibrous and muscular tunics and are not provided with valves. It is only in the large collectors of the subserous plexus that valves make their appearance.

The richness of the submucosal lymphatic plexus and its freedom from valves make it easy for infective or cancerous material to spread along the submucosal plane. There is such free communication between the lymphatics (submucosal and subserosal) of all areas of the stomach that, given obstruction to the flow through one set of collecting vessels, material injected into the subserous or submucous plexuses can readily travel in any direction from which the outflow is easiest. Thus, if the primary lymph nodes, through which a certain cancerous area of the stomach usually drains, become diseased and obstruct drainage then the drainage will take place by another route and the original disease spread in the submucosa. While the duodenal submucosa is very similar to that of the stomach, viz., a layer of loose connective tissue rich in lymphatics and blood-vessels, yet at the pylorus itself the connective tissue constituting it becomes condensed and poor in lymphatics, thus there is comparatively little direct lymphatic communication between the stomach and duodenum. The duodenal and gastric lymphatics, however, drain into the same lymph-nodes and on their way to these nodes may anastomose, and so there may, on occasion, take place a retrograde flow of lymph from the gastric into the duodenal vessels. While this exchange of lymph may not be extensive yet it must be remembered. Clinically we know that cancer can spread from the stomach to the duodenum, but that this spread is not usually extensive and may be explained in part at least by the above anatomic facts.

From a practical point of view the surgeon is interested in knowing, first, how and in what directions gastric cancer spreads in the stomach walls so that he may make his lines of incision beyond those regions which may be reasonably considered affected, although no macroscopic evidence of disease may be present; second, in what directions the disease may have spread through the lymphatics so that he may excise all those lymphatic territories which may reasonably be considered involved.

The first of these questions has been fairly answered by the remarks already made regarding the lymphatic plexuses of the stomach and duodenum. Fortunately the drainage from the pyloric and pre-pyloric portions of the stomach is so free that it is comparatively rare to find obstruction to it sufficiently extensive to dam back the infected lymph into the cardiac area, and it is cancer

of the pyloric portion of the stomach which is of particular interest to the surgeon.

The second practical question is much more difficult to answer. Practically all of the stomach drains ultimately into the glands near the celiac axis. The areas adjacent to the lesser curvature drain directly into glands along the coronary artery; the areas adjacent to the greater curvature drain into the gastro-colic glands which in turn pass into the subpyloric glands. The pylorus itself drains both upwards to the suprapyloric and downwards to the subpyloric glands (Figs. 496 and 497). Thus the subpyloric glands (Jamieson and Dobson, "Lancet," April 20, 1907) are a secondary group for the prepyloric region, but primary for the pylorus and duodenum. One or two vessels from the supra-pyloric group pass behind the duodenum to low-situated nodes on the biliary chain.

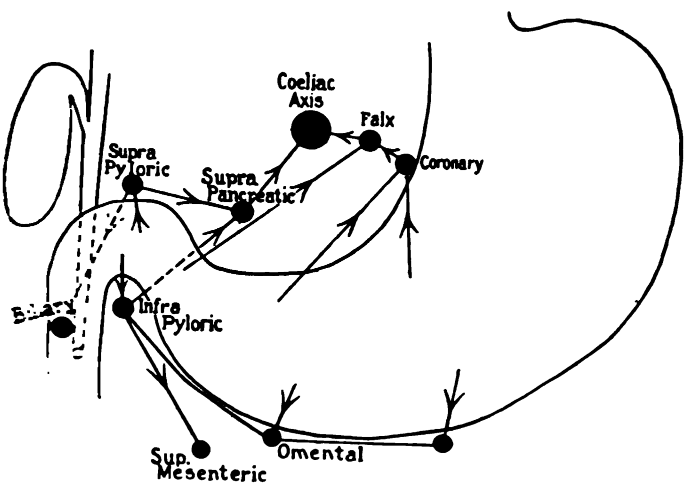


Fig. 497.

The subpyloric group drain in two directions, (1) along the gastro-duodenal artery anterior to the pancreas to the middle superior pancreatic glands which accompany the hepatic artery before its division; (2) downwards in front of the pancreas to glands lying beside the superior mesenteric artery.

Remember that the celiac axis is retroperitoneal, that the coronary artery in its course along the lesser curvature of the stomach lies in the gastro-hepatic or lesser omentum, but that that portion of the coronary artery between its origin in the celiac axis and its inclusion in the lesser omentum lies in the falx coronaria or gastro-pancreatic fold of peritoneum. A number of glands are present in this fold and through them drains the lymph from the glands in the lesser omentum. It must be remembered that certain of the lymph vessels arising near or at the pylorus pass along the lesser omentum, dodge the glands there present and pass directly into those of the falx coronaria. In operating for gastric cancer it is usually easy enough to remove with the disease the suspected lymphatics in the greate[illegible]ser omenta and the subpyloric group, but the

relation of the subpyloric vessels to the superior mesenteric group, the suprapyloric to the retroduodenal biliary group and the direct route of drainage from the pyloric region to the glands in the falx coronaria are all elements threatening success in the radical operation for gastric cancer.

Malignant disease of the pylorus usually spreads towards the cardiac end of the stomach, especially along the lesser curvature; hence in operating in malignancy it is wise to excise along with the pylorus the whole lesser curvature of the stomach and all suspected lymph-glands. "In cutting across the stomach the incisions should be 1½ to 2 inches wide of the disease at least" (Mayo Robson). As malignant disease does not, as a rule, infiltrate towards the duodenum, the division of the duodenum may be made at a point about ¾ to 1 inch away from the disease. "In excising glands from the great omentum there is great danger of wounding the middle colic artery and thereby causing gangrene of the transverse colon. The glands along the greater curvature are most numerous near the pylorus." (Mayo Robson, "Surg. Treatment Diseases of the Stomach.") This danger is avoided in the method described below.

In view of the facts stated in the preceding paragraphs, it follows that the original operations of pylorectomy were defective in extent. When a sufficiency of the viscus is removed, it will rarely, if ever, be possible to unite the open end of the duodenum to the open end of the stomach (partially closed by sutures), and when possible it will be much more difficult, time-consuming, and risky than the methods to be described.

Pylorectomy or Partial Gastrectomy.—*Step* 1.—Open the abdomen, usually by a longitudinal incision between the ensiform cartilage and the umbilicus. Explore the abdomen.

Step 2.—Tear a hole in the thin portion of the lesser omentum and through this hole feel the coronary artery as it passes in the falx coronaria (gastropancreatic fold) into the lesser omentum near the œsophageal end of the lesser curvature of the stomach. With a full curved needle pass two ligatures round the coronary vessels (Fig. 498) and divide the vessels between them. Divide the lesser omentum except that thick portion of it called the hepatoduodenal ligament in which lie the bile ducts, the portal vein, etc. (N.B. The lesser omentum is usually sufficiently divided by the tear made in it during exposure of the coronary vessels. The portion of the omentum torn is avascular and innocent of lymph nodes.)

Step 3.—Divide the anterior layer of peritoneum forming the hepatoduodenal ligament and pass the finger round the duodenum from above downwards between the gut and the portal vein, bile ducts, pancreas, etc. Expose and tie the pyloric artery.

Step 4.—Pass the left hand from above downwards behind the pylorus and stomach and lift the great omentum forward. Ligate the right gastroepiploic vessels. Ligate, in three or four segments, the great omentum. The hand behind the omentum protects the vessels of the transverse mesocolon from being included accidentally in the ligatures. Should this accident happen

the devascularized transverse colon must of course be removed (enterectomy). Ligate the left gastro-epiploic artery well to the left of the disease and of the last of the glands in the great omentum if the disease is cancer. Divide the great omentum leaving attached to the stomach that portion containing lymph nodes. As the gastro-colic omentum is being divided "it will sometimes be found that the avascular area which lies in the circle of the middle colic vessels and the posterior layer of the mesocolic peritoneum is attached to the growth. If this is the case the attached peritoneum can be cut out and removed with the growth. The opening thus made in the transverse mesocolon can be used later through which to make the gastro-jejunostomy" (Mayo).

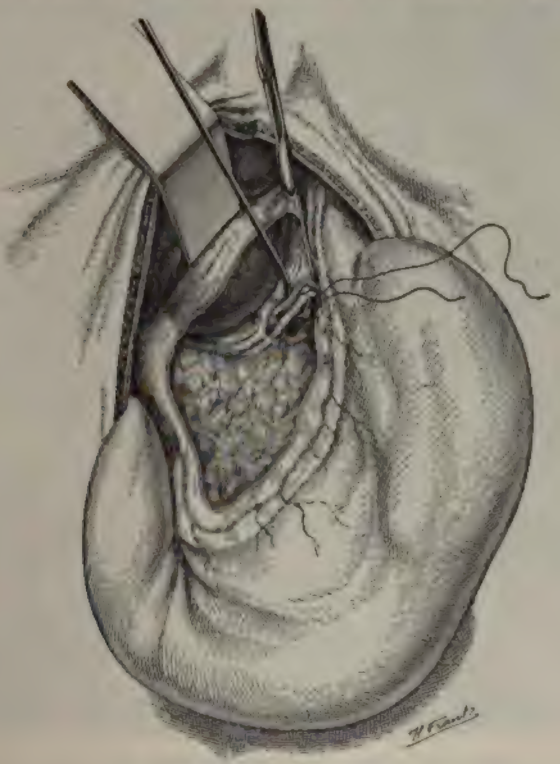


FIG. 498.—(*Guibe.*)

Step 5.—Continue the division of the gastro-colic omentum towards the right so as to get below and to the right of the inferior gastro-duodenal lymph nodes situated below and to the right of the pylorus about the head of the pancreas (Figs. 496, 497, 508). Lift up the fat and glands from over the head of the pancreas separating them from the curve of the duodenum but leaving them attached to the stomach and pylorus. During the above dissection the vessels anastomosing with the branches of the superior pancreato-duodenal artery are exposed and tied. Continue the dissection until at least 2 inches of the inferior border of the duodenum is cleared and the gastro-duodenal artery is

exposed in the groove between the head of the pancreas and the duodenum. Ligate and divide the gastro-duodenal vessels. This permits thorough removal of the glands.

Step 6.—If the gastric growth is adherent to the pancreas, shave off a portion of the pancreas leaving the shaved-off portion attached to the stomach. If the involvement of the pancreas is extensive "it is better to leave this part of the operation until the stomach is either cut across and separated from the duodenum or the line of stomach section on the cardiac side is finished and the stomach turned over in order that this portion of the dissection may be

FIG. 499.—Blood vessels tied, glands separated, crushing forceps in place, and also clamps to prevent leakage from part to be removed. Upper left drawing shows stump of duodenum in crushing clamp with suture placed for closing. (*Mayo.*)

completed under inspection. If such injuries to the pancreas are properly cared for, we have not found that they give rise to serious consequences. . . . The best manner of treating such an injury to the pancreas is to cover it as far as practicable with the sheath and posterior peritoneum, and after completely closing the end of the duodenum, if possible the stump of the duodenum should be buried in the injured surface of the pancreas" (Mayo).

Apply two clamps to the duodenum distal to the disease and about ½ inch apart. The distal clamp should be a very powerful crushing one like

Payr's; for the proximal segment of gut any efficient clamp, such as Ochsner's, will serve. Cut between the clamps with a cautery and burn the stumps protruding from the clamps even to such an extent that the Payr's clamp is heated sufficiently to char the tissues crushed between its jaws. Insert a continuous fine chromic catgut suture, in the Cushing fashion, the bites being alternately on each side of the clamp and the threads crossing it (Fig. 499).

Remove the Payr's clamp, pulling its blades out from under the threads. The divided duodenum is so crushed and charred that it remains closed. Pull on the ends of the suture. As tension is put on the suture the wound becomes

FIG. 500.—Crush clamp on stomach. Cautery used to sterilize and prevent carcinomatous implantation. Stump of duodenum closed. Sutures placed to turn the duodenal stump into the denuded head of the pancreas. (*Mayo*.)

inverted as by a continuous Lembert suture. Fasten the ends of the suture. Put in an extra line of silk mattress sutures to reinforce the closure. Suture the duodenal stump to the area of pancreas denuded during the mobilization of the duodenum or to the edge of the fascia which covered the pancreas.

Step 7.—Choose the line of section on the stomach to the left of the lymphatic glands into which the diseased area drains (Figs. 506, 507, 508). To the cardiac side of this line apply Payr's large crushing clamp; to the pyloric side apply any efficient clamp. Divide the stomach between the forceps

with the cautery and remove the diseased segment. Insert a chromicized catgut suture in the stomach stump exactly as was done in the duodenal stump, tightening the suture as the Payr's clamp is removed. Reinforce the line of suture by a few mattress or Gould sutures of silk or linen and bury these by a line of interrupted silk or linen sutures.

Step 8.—Perform a posterior gastro-jejunostomy.

If the portion of the stomach left after excision of the disease is very small it might be technically difficult to perform gastro-jejunostomy and the second

FIG. 501.—Upper jejunum, 6 to 12 inches from origin, brought through an opening which has been made in the transverse mesocolon and united by outer row of sero-muscular silk sutures to posterior wall of stomach. (*Mayo.*)

operation might well jeopardize the nutrition of the gastric stump. To avoid these evils the latter part of Step 7 may be modified by using a method of anastomosis credited by Mayo to Pólya and by Bier to Krönlein. Instead of closing the gastric stump as described above, anastomose it to the side of the jejunum as follows: Make an opening in an avascular portion of the transverse mesocolon; pull the upper jejunum through this opening and lay it along side the stomach stump without tension. Apply an intestinal clamp to the loop

of jejunum exactly as in gastro-jejunostomy. Unite the jejunum to the posterior wall of the stomach behind the Payr's clamp by a row of interrupted silk sutures (Lembert or Gould sutures) (Fig. 501).

Apply an intestinal clamp to the stomach proximal to the line of serous sutures. Remove the Payr's clamp. Unite the open end of the stomach to a

FIG. 502.—Crushing clamp removed from the stomach and holding clamps applied to jejunum and stomach to prevent soiling. (*Mayo.*)

corresponding opening now made in the jejunum, by a row of through-and-through sutures of chromicized catgut, exactly as in gastro-jejunostomy (Figs. 502 and 503). Remove the intestinal clamps and introduce the anterior row of

silk Lembert sutures. Draw the entire anastomosed end of the stomach down through the opening in the transverse mesocolon. Unite the edges of the opening in the mesocolon to the stomach wall (Fig. 504). Sometimes it is not easy to

FIG. 503.—Inner row of catgut through-and-through sutures applied to the posterior walls, uniting jejunum to cut end of the stomach and continuing part way down the anterior wall. (*Mayo.*)

pull the jejunum up to the upper end of the opening in the stomach or to keep it there without tension. Under these circumstances it is easy to apply an intestinal clamp well back of the Payr's clamp and after removing the latter to

close the upper end of the gastric opening by two rows of suture and then to anastomose the side of the jejunum to the low part of the stomach opening. When this is done it is well to suture the jejunum to the stomach for a short distance above the site of anastomosis so that the unopened jejunum acts as a patch applied to a part of the line of suture closing the stomach (Fig. 505).

Fig. 504.—Anastomosis completed by an anterior row of sero-muscular silk sutures. Anastomosed and brought through the opening in transverse mesocolon, and margins of opening sutured to the stomach. (*Mayo.*)

Moynihan's Technic.—The sequence of steps in the operation as performed by Moynihan is as follows:

The belly having been opened and parts exposed.

(*a*) Divide the duodenum between crushing clamps. Catch and ligate vessels individually. Find and remove the subpyloric (subduodenal) lymph nodes which lie near the second part of the duodenum.

(*b*) Divide, between ligatures, the gastro-colic omentum.

(*c*) Divide, between ligatures, the gastro-hepatic omentum as high up as

possible. Ligate the coronary artery late; this permits access to it at a high level and give access to some high lymph nodes into which lymphatics drain directly from the pyloric region. Remove the nodes.

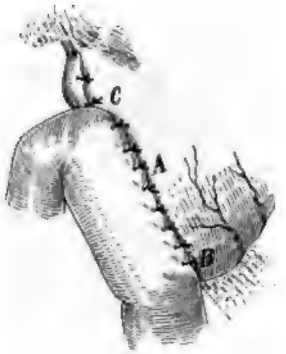


FIG. 505.—The stomach has been closed from the lesser curvature to the point *A*. *A.B.* is the site of anastomosis. *A.C.*, a portion of jejunum acting as a patch over Billroth's fatal angle.

(*d*) Tear a hole in the mesocolon and pull a loop of jejunum through it. Perform posterior gastro-enterostomy using the cardiac portion of the stomach.

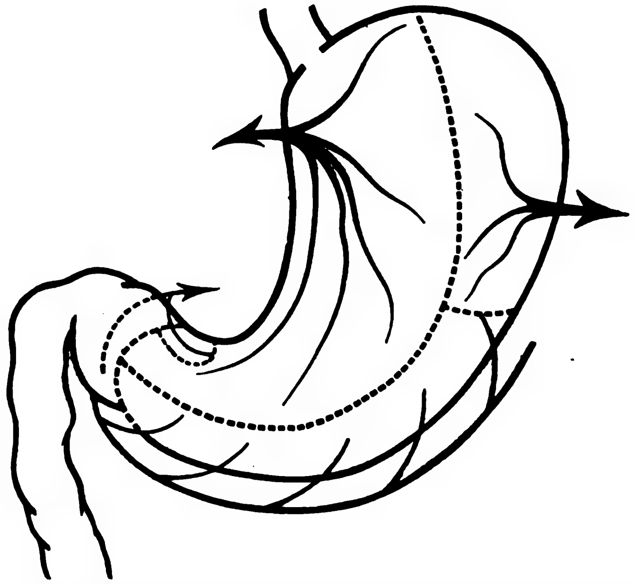


FIG. 506.—Lymphatic drainage areas of stomach. (*Cuneo.*)

The anastomosis is more easily performed before rather than after excising the portion of stomach to be removed.

(*e*) Choose the line of section on stomach. Put in a stay or traction suture on the lesser curvature well proximal to the line of section. Apply a clamp to

the stomach ¾ inch proximal to the line of section and distal to the stay suture which forms a great safety if the clamp slips.

(*f*) Divide the stomach with the cautery.

(*g*) Suture the mucosa with catgut. Apply two layers of continuous Lembert (Cushing) sutures, after removing the clamp.

(*h*) Fix the cut edge of the gastro-colic omentum to the lower end of the stomach.

(*i*) Attend to the duodenal stump in the usual fashion and then attach it by a stitch to the anterior surface of the pancreas.

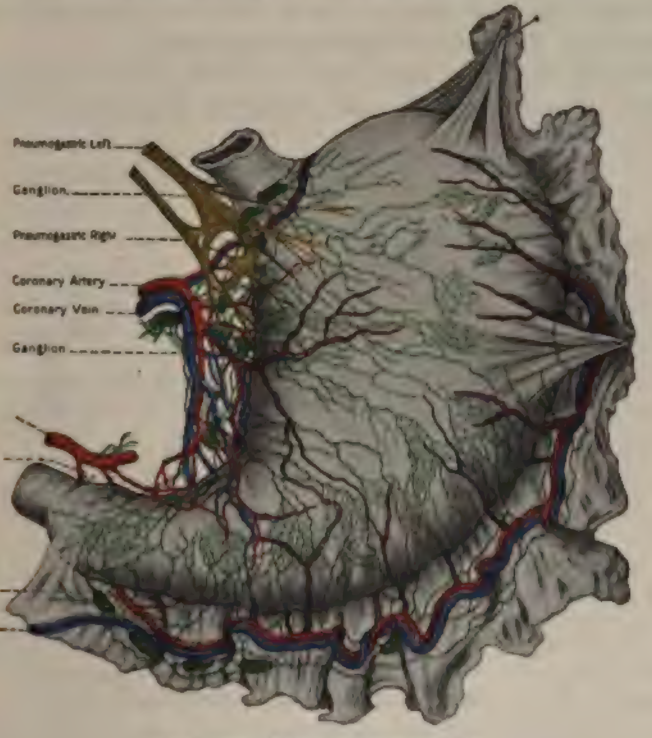


FIG. 507.—(*Mayo, after Cuneo.*)

(*j*) Pull the great omentum up in front of the transverse colon and tuck it into the cavity now existing above the colon.

After-treatment.—The special rules for the after-treatment of stomach operations are, shortly, as follows:

(*a*) If the patient is much dehydrated, give intravenous or subcutaneous infusions of saline solutions. These may be repeated during a few days if necessary. If not dehydrated and if stimulation is necessary, administer subcutaneously a 20 per cent. solution of camphor in sterile olive oil. As the patient leaves the operating-table 8 ounces of warm coffee should be given per rectum. Morphine in an efficient dose may be administered if required.

(*b*) As soon as the effects of the anesthetic wear off (within a few hours)

raise the patient into a sitting or rather semi-sitting posture. This tends to obviate pulmonary disturbances and is important.

(c) Twelve hours after operation small doses of hot water may be given by the mouth; and next day, if there is no nausea, an ounce of hot water may be given hourly.

(d) Nourishment must be by rectal feeding for from four to six days after operation, when fluid food may be given by the mouth. After thirty-six hours, experiments with small quantities of predigested liquid food may be instituted. See footnote, page 353.

(e) If a drain has been used, it may be removed about the sixth day.

Ultimate results of resection of the stomach for cancer.

Out of ninety-four cases which survived three years or longer and which were without recurrence at the beginning of the third year only five suffered

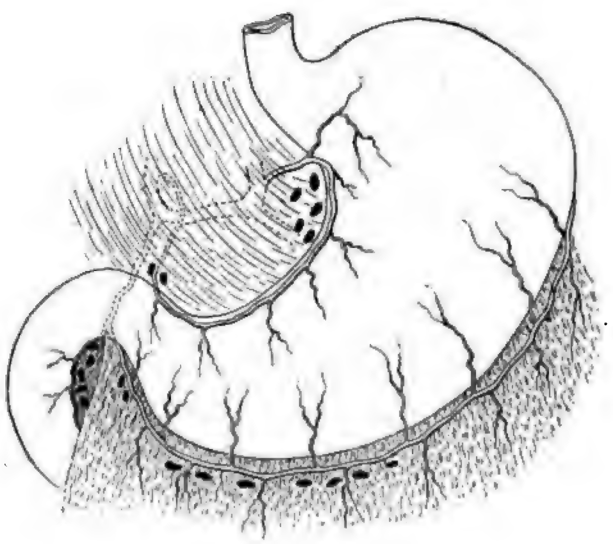


FIG. 508.—Lymphatics of stomach.

from later recurrence. Of the remaining eighty-nine cases the cures had persisted sixteen years in one, ten years in five, and from five to ten years in thirty-four. The hope of permanent cure, according to Leriche's figures, is about 20 per cent. [Leriche, "Rev. de. Med.," Feb., 1906. Ref. "Zentralblatt für Chir.," 1907, No. 29.]

The Mayos' statistics of partial gastrectomies and pylorectomies performed between April, 1897, and January, 1910, are as follows:

Number of operations 266 with thirty-four deaths (12.4 per cent.). Forty-two of the operations were *not* for cancer. During 1909 there were forty-six operations with four deaths (8.6 per cent.).

Operations for carcinoma involving the pyloric end of the stomach:

Total number, 224.

Average age, 53.

Patients operated on over five years ago:

Total number, 50.

Present condition known, 39.

Alive and well: one 8 years, 2½ months; one 8 years; one 7 years 2 months (has since died of recurrence); one 6 years; one 6 years, 11 months; one 5 years, 3½ months; one 5 years. Total, 8.

Patients operated on over four years ago:

Total number, 85.

Present condition known, 64.

Alive and well, 13.

Patients operated on over three years ago:

Total number, 117.

Present condition known, 88.

Alive and well, 18.

Patients operated on less than three years ago:

Total number, 107.

In one case of gastric carcinoma operated on by the author the stomach was inseparably adherent to the abdominal wall at the umbilicus and also adherent to the pancreas. The umbilicus was excised along with most of the stomach. Three years after the operation the patient was well.

Excision of Cardia and Abdominal Œsophagus.—H. Boit (Zent. für Chir., xvi, May, 1914) has frequently successfully operated on dogs and once unsuccessfully on man, in the following manner:

Anesthesia by the Sauerbruch or Meltzer-Auer method.

"Left dorsal flap incision with base near spine. Temporary division of the ribs from the eighth to twelfth near the longitudinal muscles of the back. Longitudinal opening of the pleura and peritoneum. Intercostal incision in the seventh interspace. With retraction of the wound in chest. Division of the tendinous diaphragm up to the cardia. Separation of the cardiac end of the stomach and of the affected œsophagus. Division of both vagi immediately above the diaphragm. The stomach and œsophagus can now be pulled out of the wound and the operation carried on outside of the body. Completely protect the chest cavity, mediastinum and abdomen with pads. Resect a segment of stomach and œsophagus. To avoid subsequent stenosis divide the œsophagus obliquely. Close the wound in the stomach. Make an anastomosis between the fundus of the stomach and the stump of the œsophagus using two rows of *interrupted* sutures. Suture both halves of the divided diaphragm over the line of anastomosis in such a way as to provide the latter with a peritoneal covering. Close the diaphragmatic and mediastinal wounds. Close the chest under hyperpressure." The great danger apart from shock consists in suture insufficiency. This is prevented by avoidance of too great dissection of the œsophagus, avoidance of tearing and crushing of the œsophageal stump and in avoidance of tension on the sutures. Usually the operation must be preceded by jejunostomy to permit of nourishment being given. During the laparotomy the abdomen must be explored to determine if the major operation is justifiable.

CHAPTER XXXIV

OPERATIONS ON THE INTESTINES

Apart from operations which are essentially directed against the biliary passages, or from the operation of gastro-duodenostomy, the only lesion commonly calling for interference with the duodenum is ulceration. Duodenal ulceration is much more common than is usually supposed. The operative treatment depends on the presence or absence of perforation.

Perforation of the Duodenum.—The ulcer is almost invariably situated in the first 2½ inches of the gut, and is, therefore, accessible.

Step 1.—Open the abdomen by the right rectus incision. Guided by evidences of inflammation and by anatomical knowledge, expose the disease.

Step 2.—Cleanse the affected area. Protect the rest of the belly with gauze. If possible, close the perforations by Lembert sutures. Reinforce the suture by an omental graft. If possible make the line of suture transverse to the long axis of the bowel; this to avoid stricture. In one case H. S. Clogg ("Brit. Med. Jour.," Jan. 2, 1905), unable to close the perforation by sutures, brought up the free edge of the omentum and stitched it around the perforation with excellent effect. One must remember, however, that this procedure might form the excuse for the occurrence of an internal hernia. A free, *i.e.*, non-pedunculated omental graft is entirely preferable. Murphy writes: "Where the intestinal wall is indurated and adherent to neighboring tissues it must be sufficiently liberated and freed to admit of an easy apposition of its convex surfaces with two rows of suture. The failure to free the intestine from neighboring structures is the most common cause of failure of union."

Step 3.—Provide for drainage through the primary incision; through a special opening made in the right loin just below the last rib, or when there is much peritonitis, provide pelvic drainage through an anterior wound and keep the patient in the Fowler position.

When the patient's general condition is good, it might be wise to follow Step 3 by performing a gastro-enterostomy so as to give rest to the duodenum and permit healing of the ulcer.

Corner has treated duodenal and gastric perforations by mere plugging with a strip of gauze. This seems a very risky procedure as a duodenal fistula oes not tend to close spontaneously and unclosed is invariably fatal.

A. A. Berg recommends treatment of duodenal fistulæ by means of gastro-enterostomy *plus* pyloric occlusion. This is thoroughly logical. Pannett (Lancet, April 18, 1914) in a case of duodenal fistula when the patient was *in extremis* from starvation, established a jejunostomy after the Witzel method, at the same time anastomosing the loop of jejunum going to, with that coming

jejunostomy opening. Pannett claims the following advantages for my "it is technically a simpler operation, because there are few or no to be dealt with; a septic area of the abdomen has not to be opened ormal functioning of the pancreas is not interfered with by hindering ition of the hormone of the pancreas (secretin), which occluding the oes.

lisadvantage lies in the fact that a subsequent gastro-jejunostomy, become necessary, would be a very difficult and complicated pro- Nevertheless, I think this operation will become the method of choice, o has found that very few perforated duodenal ulcers subsequently istro-jejunostomy."

enal Ulceration without Perforation.—The treatment of ulceration quel, stenosis, is gastro-enterostomy.

otomy and Closure of Intestinal Perforations.—Enterotomy is the performed for the extraction of foreign bodies or for the evacuation nal contents in certain cases of ob- where enterostomy is not indicated. osure of the gut after incision is simi- e procedure required in perforation, subjects may be treated together.

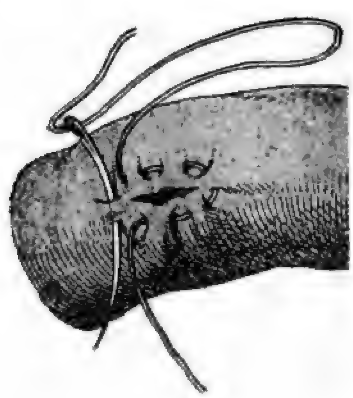


FIG. 509.—Purse-string suture. (*Monod and Vanverts.*)

1.—Expose the intestine by an inci- r near the median line. Exception- other incision is preferable.

2.—Find and pull out of the belly of gut to be attacked. (If the case perforation, empty the loop by strip- rith the fingers and apply clamps or iivalent.) Protect the belly cavity s.

3.—Make a longitudinal incision the intestinal wall on the side opposite to the mesenteric attachment. the foreign body. Undoubtedly a longitudinal incision when closed the gut lumen more than does a transverse, but the amount and of this narrowing have been much exaggerated and the longitudinal e more convenient and practical.

4.—Closure of the intestinal wound.

If the opening is very small, one or two points of Lembert sutures will r a purse-string suture may be better (Fig. 509).

If the opening, while longer, is linear, insert a row of continuous through- ugh sutures for hemostasis and occlusion, and cover these by a line ert sutures, either continuous or interrupted. Some surgeons do not eep row of sutures, but it is both a convenient and a safe procedure.

If the opening is large, or so contused or diseased that sutures close t hold, direct closure, whether transverse or longitudinal, leads truction (Fig. 510). The effects of the resulting stenosis may

be discounted by making an anastomosis between the loop of gut leading to and that going from the stenosis, or the injured segment of intestine may be excised.

Step 5.—Cleanse the exposed gut. Review the line of suture reinforcing it, where necessary, by points of Lembert sutures. Remove the protective pads. Replace the intestines in the belly.

Step 6.—Close the belly. Apply dressings.

If there is any fear that the intestinal sutures will fail to do their duty, many, probably most, surgeons apply a wick of gauze or cigarette drain to the wounded gut, bringing the free end of the drain out through the parietal wound. To the writer it appears that such a precaution is liable to lead to the very state of affairs it is meant to prevent; that the foreign body or drain close to the line of suture may possibly interfere with the process of repair.

Lateral Anastomosis by Means of Suture.—The following operation is in all essentials that described by Abbé:

Step 1.—Bring outside the abdominal cavity, which is protected by gauze pads, the loops of gut to be united. Place the loops together in such a manner

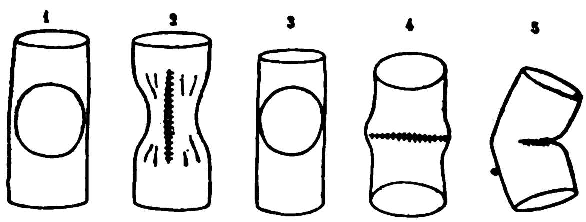


FIG. 510.—Intestinal perforation. (*Monod and Vanverts.*)

that about five inches lie in contact. Squeeze the contents out of the loops and apply suitable clamps to keep them empty.

Step 2.—Unite the two loops of gut for about four inches by a row of continuous suture (continuous Lembert), parallel to and not far from the mesenteric border. The stitches involve the serous, muscular, and fibrous or sub-mucous tunics. Fasten the suture with a knot (Fig. 511). The objection to continuous non-absorbable sutures when used in gastro-enterostomy does not apply in the case of the intestine where if the suture causes any irritation it is promptly sloughed into the gut and no harm results.

Step 3.—At a safe distance from the line of suture A, B, make the opening X, Y, in one of the loops. The opening must be about one inch shorter than the line of suture A, B. A portion of intestinal wall about one-half inch in width may be excised along the line of the opening X, Y. This, however, is optional. Seize any bleeding points with forceps. Payr ("Zent. für Chir.," March 23, 1912) wipes the mucosa dry and paints it with tincture of iodine. This sterilization of the mucosa he finds to be very useful. Repeat Step 3 on the other loop of gut.

Step 4.—With a continuous catgut suture unite the corresponding edges of the openings in the two loops of gut (Fig. 512). This continuous suture

involves all the coats of the intestine and shuts off the intestinal cavity from the line of Lembert sutures; at the same time it prevents loss of blood. The suture may be applied in the Connell fashion. v. Schmieden ("Zent. f. Chir.," April 15, 1911, No. 15, p. 531) advises using the old-fashioned postmortem suture for the anterior mucosa suture (Fig. 513). This inverts all the coats of the gut. Roosing uses a similar stitch.

Step 5.—Continue the line of suture A, B (posterior row of Lembert suture) completely around the site of the anastomosis (Fig. 466, L, L, L), thus entirely burying from view the occlusion or hemostatic sutures introduced in Step 4. Fig. 514 shows the last of these sutures being introduced in the interrupted fashion. The continuous suture is as good as, or really better than, the interrupted.

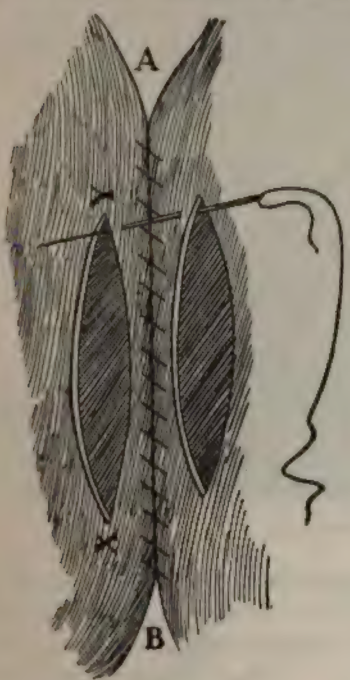


FIG. 511.

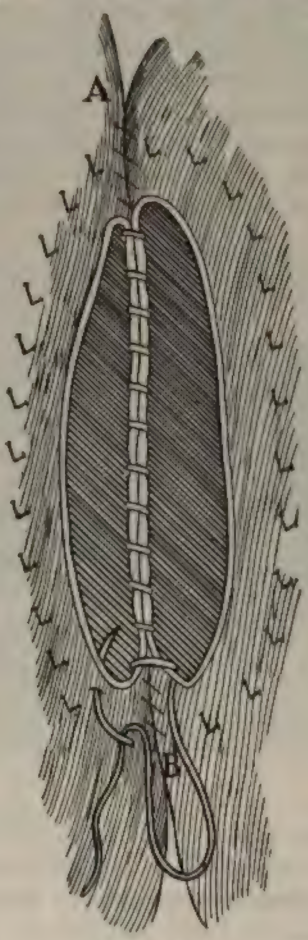


FIG. 512.

FIGS. 511 AND 512.—Abbe's operation.

Step 6.—Review the line of suture and if necessary reinforce it by a few extra stitches. Fig. 515 shows a sectional view of the anastomosis.

Step 7.—Remove the intestinal clamps. Clean the wound. Remove gauze pads. Return the intestines. Close the abdominal wound.

Dr. Charles T. Parkes recommended a smaller opening in the gut than that described above. After making a longitudinal incision through the

intestinal wall at a point *opposite* the mesenteric attachment, he made a short transverse incision at either end of it and so formed two flaps of gut-wall which he turned inwards, fastening them in this position by a few sutures. The turning-in of the flaps prevented contraction of the anastomotic openings. After making the openings in the opposing loops of gut, Parks completed the union by a single row of continuous Lembert sutures, each stitch involving one-third inch of intestinal wall, the stitches being one-eighth of an inch apart.

"It makes no difference whatever what kind of suture is used, so that the principle of positively securing the application of two broad surfaces of peritoneum in contact with each other is certainly carried out." (Parkes.)

Fig. 516 shows how the Abbé operation may be more conveniently performed with the aid of two gastro-enterostomy clamps. The clamps used as

FIG. 513.—(*Schmieden.*)

in the diagram simplify the operation amazingly, hold the segments of gut in convenient position, prevent bleeding and prevent escape of intestinal contents.

Lateral Anastomosis by Means of the Murphy Button.—*Step* 1.—Having opened the belly, pull the two loops of gut which it is desired to unite out from the abdominal cavity and protect the latter with gauze pads. Empty the segments of intestine and keep them empty by means of clamps.

Step 2.—Introduce a purse-string suture of fairly stout silk or catgut into the gut opposite its mesenteric attachment. The suture pierces all the coats of the gut. Make a longitudinal opening into the gut, large enough to permit the introduction of a Murphy button of appropriate size. This cut is in the area surrounded by the purse-string suture (Fig. 517).

Step 3.—Seize one-half of the Murphy button with hemostatic forceps and introduce its head into the gut. Weir has found that the forceps may so injure the button as to render it unsafe. Dawbarn plugs the two segments of the

button with corks, thus providing handles and at the same time preventing escape of intestinal contents. Cordier has devised ingenious metal handles to plug the button and take the place of the corks.

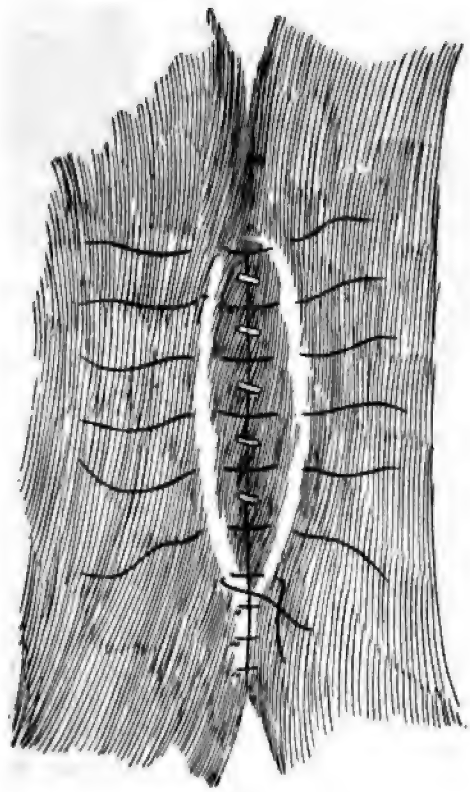


FIG. 514.—Abbe's operation.

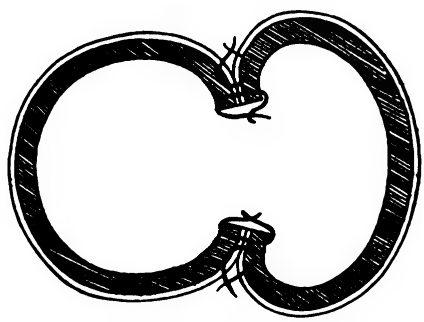


FIG. 515.—Lateral anastomosis.

Pull the purse-string tight and tie it in such a manner that the opening in the gut is snugly fastened around the neck of the button (Fig. 518). With scissors or knife remove any excess of tissue distal to the suture which might interfere with the proper approximation of the two halves of the button.

Repeat Steps 2 and 3 on the other loop of gut.

Step 4.—Remove the hemostatic forceps or corks from the two halves of the button. Insert the neck of the male half of the button into that of the female half and push them together firmly (Figs. 519 and 520). A few points of Lembert suture may be used to reinforce the union.

In Step 2 the incision may be made into the gut before the purse-string suture is introduced. A good method of applying the stitch is shown in Fig. 521.

Anastomosis by Means of McGraw's Elastic Ligature.—*Steps* 1 and 2 are identical with the operation by means of suture.

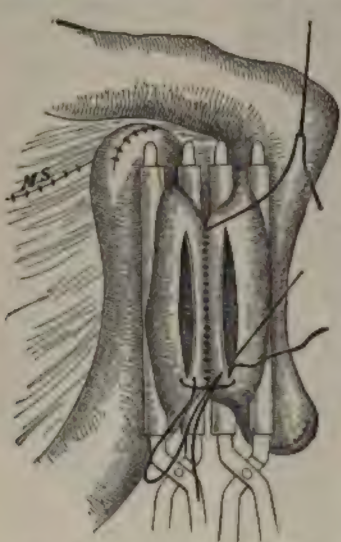


FIG. 516.—Lateral anastomosis.

Clamps in place. Posterior row serous sutures in place. Gut incised; through-and-through or Connell suture begun. When the through-and-through suture is in place completely around the anastomotic opening, remove the clamps and then insert the anterior row of serous sutures. In this diagram it is assumed that a portion of gut has been excised; that both afferent and efferent loops have been closed. M. S. indicates the line of union of the mesentery of the two loops of the gut. No holes must be left in the mesentery.

Step 3.—Thread a piece of well-rounded elastic-cord, about 3 mm. in diameter, in a straight Hagedorn needle. (The end of the cord is tapered with a knife to permit of threading.) Pass the needle into the lumen of the gut and out again at a point about 2½ inches distant. The track of the needle corresponds to the incision made into the gut in the suture operation. With a sharp jerk pull the needle and with it the elastic cord through the intestinal walls. The assistant keeps the cord on the stretch during this manœuvre. Repeat this in the opposite direction on the other loop of gut. Tighten the ligature as much as possible; cross its ends and secure them by a stout silk thread passed underneath and tied on top.

Step 4.—Complete the line of continuous Lembert suture around the site of anastomosis thus entirely hiding the elastic ligature. This finishes the intestinal part of the operation.

The elastic cord or ligature establishes a communication between the two loops of gut in from three to four days. By its use dangers of soiling the peritoneum by visceral contents escaping during the operation are eliminated. In the hands of McGraw, Willy Meyer, and others the method has proved very satisfactory.

End-to-end Anastomosis; Circular Enterorrhaphy.—In making an end-to-end anastomosis, whether by means of suture or the Murphy button, it is of prime importance to understand the anatomy of the mesenteric insertion. When the mesentery approaches the gut, its two peritoneal surfaces separate to surround the intestine and leave a Λ-shaped space loosely filled with fat and containing the vessels going to or from the gut. Opposite this space the muscular tunics lie uncovered by peritoneum. The most important stitch

in circular enterorrhaphy is that which closes this space. The author has frequently operated with satisfaction in the following manner:

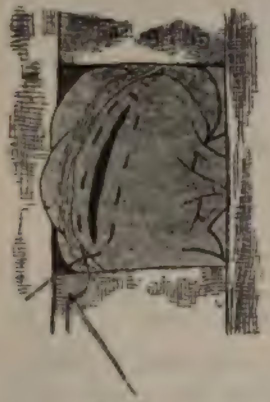


FIG. 517.

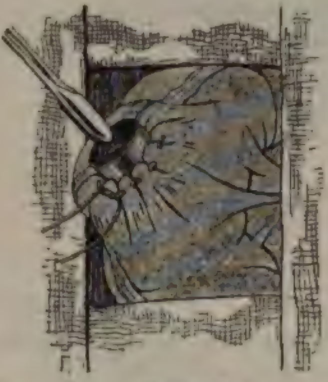


FIG. 518.

FIGS. 517 AND 518.—Use of Murphy's button. (*Monod and Vanverts.*)

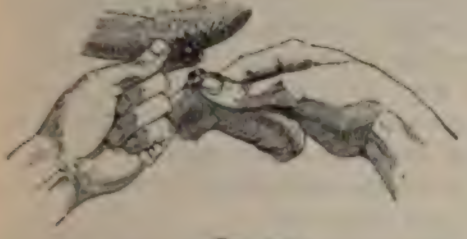


FIG. 519.

FIG. 520.

FIGS. 519 AND 520.—Use of Murphy's button. (*Monod and Vanverts.*)

FIG. 521.—Use of Murphy's button.

Step 1.—Bring the divided ends of the two segments of gut together outside the belly cavity. Unite them by a stitch of silk or catgut at a point beside the mesenteric attachment, at a point on the free edge, and at a point

midway between these two (Fig. 522). These three stitches insure uniformity in suturing. The same end may be attained by the use of miniature volsella. With a continuous suture, involving all the coats of the gut, complete the union of the two segments (Fig. 523). This suture stops bleeding and prevents contamination of the next or essential row of sutures by the intestinal contents.

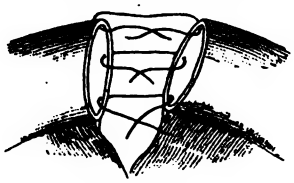


FIG. 522.

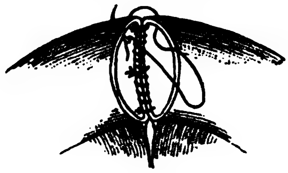


FIG. 523.

FIGS. 522 AND 523. Circular enterorrhaphy.

Step 2.—At the mesenteric attachment introduce a Mitchell-Hunner mesenteric mattress suture (Fig. 524), involving the serous, muscular, and submucous tunics. To secure serous apposition at the mesenteric space there is no suture comparable to the above. The suture shown in Fig. 525 is less desirable.

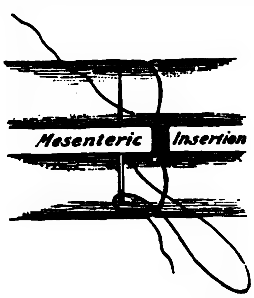


FIG. 524.—Mitchell-Hunner stitch.

Step 3.—Introduce a Lembert suture at the free margin of the gut opposite the mesenteric attachment. Introduce a continuous Lembert suture all around the gut. Each stitch should pick up about 1/8 inch of the serous and subjacent muscular tunics. Do not pull the stitches very tight; all that is required is that serous coat should be kept in touch with serous coat (Fig. 526).

Step 4.—Review the wound. Where advisable reinforce the line of union with Lembert sutures. Beware, however, of causing too much invagination of the wound and thus producing stenosis.

The late Dr. Chas. T. Parkes made use of the continuous Lembert suture in the manner described, but omitted the provisional suture which penetrates

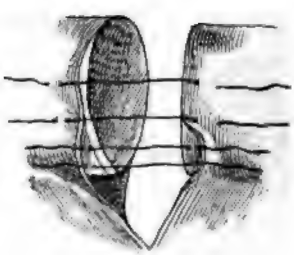


FIG. 525.


FIG. 526.

FIGS. 525 AND 526.—Circular enterorrhaphy.

all the coats of the gut. Parkes writes, *apropos* of his experimental work: "The greatest number of mishaps followed drawing the sutures too tightly,

which, if done, leads to death of the applied edges, and, of course, to failure. They must be drawn only sufficiently close to bring the surfaces fairly in contact; the subsequent swelling from obstructed circulation will hold the surfaces firmly together until glued to each other by the rapidly forming adhesive material."

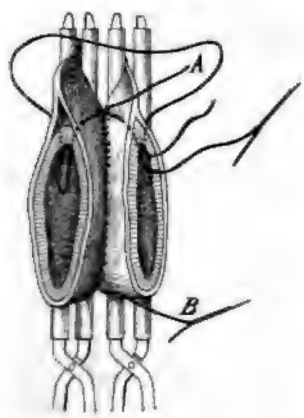


Fig. 527.

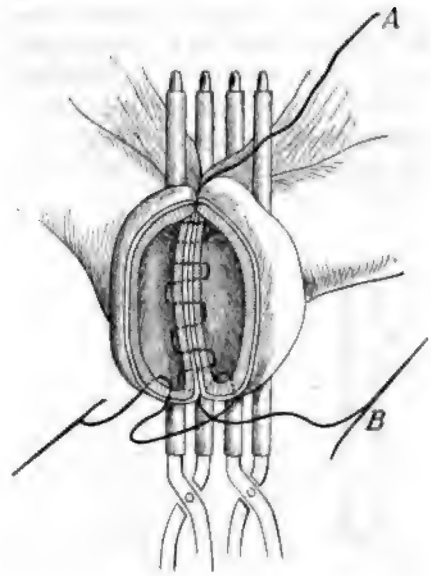


Fig. 528.

Figs. 527 and 528.—Connell's suture.

End-to-end anastomosis is most easily performed with the aid of clamps. Any good intestinal clamps, with rubber tubing over the blades, are suitable.

Step 1.—Clamp each of the segments of gut about one inch from their open ends. Place the clamps and contained gut side by side (Fig. 527).

Step 2.—Introduce the posterior row of continuous Lembert sutures (AB, Fig. 527).

Step 3.—Beginning at the mesenteric attachment, introduce a Connell suture (Figs. 527 and 528) completely around the gut, closing it entirely.

Step 4.—Complete the introduction of the continuous Lembert suture (AB, Fig. 529).

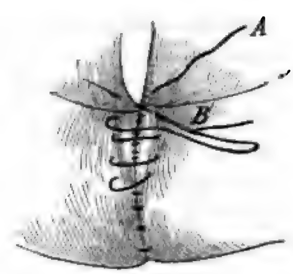


Fig. 529.—Circular enterorrhaphy.

Step 5.—Close the rent in the mesentery.

Maunsell's Operation.—A portion of gut is supposed to have been excised.

Step 1.—Unite the severed ends of the gut by two sutures involving the whole thickness of the intestinal wall. One suture is inserted near the mesentery, the other on the opposite side of the intestine. The ends of both sutures are left long (Fig. 530).

Step 2.—On the free margin of the larger segment of gut (Fig. 530) make the longitudinal cut "*a*" at least one inch from the point of insertion of sutures.

Step 3.—With an eyed probe push the long sutures through the lumen of the gut and out of the cut "*a*." Pull upon the threads until the divided ends of the gut emerge through the opening "*a*." Looking at the double tube of gut protruding through the opening "*a*" note that their peritoneal surfaces are in contact (Figs. 531 and 532).

Step 4.—Pass a straight, fine seamstress' needle through the protruded tube of gut and thus introduce about ten sutures of fine horse-hair or silkworm-gut. The sutures should be inserted about ¼ of an inch from the cut edge of gut. Pick up the sutures as they pass through the lumen of the gut and divide them, thus obtaining twenty sutures in position instead of ten. Tie the

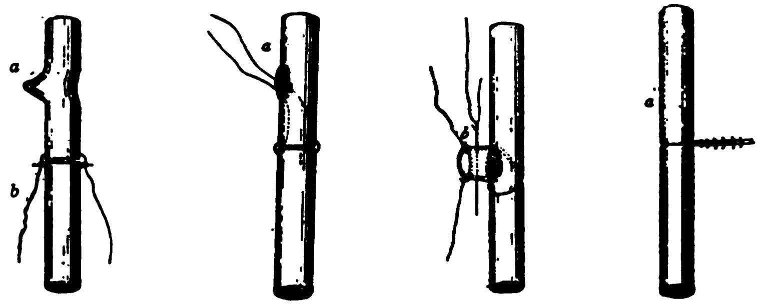


FIG. 530. FIG. 531. FIG. 532. FIG. 533.
FIGS. 530, 531, 532 AND 533.—Maunsell's operation. (*Maylard.*)

sutures. Iodoformize the line of stitches. Cut short the temporary stitches. Pull the protruded portion of bowel back into its normal position.

Step 5.—Close the wound "*a*" by appropriate sutures. Repair the mesentery (Fig. 533).

End-to-end Union by Means of the Murphy Button.—This operation is practically the same as that described for lateral anastomosis. The only point to be specially noticed is the method of closing the mesenteric space or insertion with the purse-string suture. Figs. 521, 534, 535, 536 explain themselves.

An endless number of contrivances—decalcified bone plates and bobbins, rawhide plates, catgut rings, segmented rubber rings, vegetable plates, etc.—have been invented to simplify intestinal anastomosis, but most have been discarded as cumbersome and unnecessary. The same may be said of numerous devices to support or distend the lumen of the gut while stitches are being inserted.

Of these, Harrington's segmented metal ring is probably by far the best. (See "Trans. Am. Surg. Assoc.," vol. xxii.)

The operation of lateral implantation, *i.e.*, where the end of one segment of gut is anastomosed to the side of another, is a combination of end-to-end and of lateral anastomoses, and is sufficiently explained by Figs. 537 and 538.

39 to 543 show a number of varieties of intestinal anastomosis and ation.

ll's method of enterorrhaphy is similar to Maunsell's in that the sutures the whole thickness of the gut-wall, and differs from it in the absence ond incision into the gut.

.—Place the ends of the gut in apposition, with the mesenteric attach- ne side corresponding to that of the other. Introduce two or more

Fig. 534.

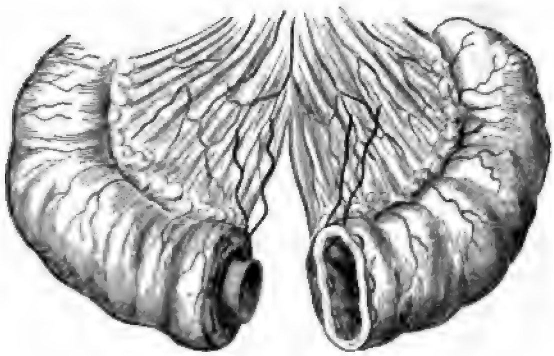


Fig. 535.

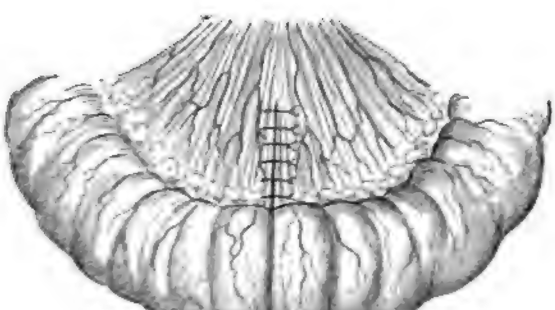


Fig. 536.

Figs. 534, 535 and 536.—Use of Murphy's button. (DaCosta.)

tures. (Fig. 544), to insure accuracy and uniformity in stitching. fixation sutures, miniature volsella may be employed. Introduce ous suture (S) as shown in Fig. 544. In this manner fully two- ven three-fourths of the circumference of the gut may be united. ning third or fourth of the wound is not so simply united, but if carefully studied, the method will be clearly understood. When

the two portions of gut are united and the suture pulled sufficiently tight, the two ends of the suture T, S emerge at the same point (Fig. 546, x).

Step 2.—Introduce through the line of suture at the point Y (Fig. 546) a threaded needle. Make the eye-end of the needle emerge alongside the sutures T and S, at the point x. Pass the ends of T and S through the loop of the thread in the needle and with the needle pull them out through the point Y.

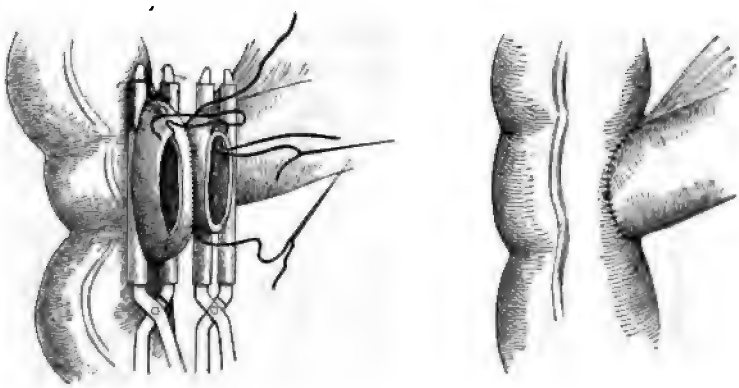


FIG. 537. FIG. 538.
FIGS. 537 AND 538.—Lateral implantation.

Step 3.—Slight traction on T and S will bring the mucous surface of the gut at the point x into contact with the mucous surface at the point Y (Fig. 547). If now the sutures T and S are tied tightly together and the knot allowed to slip through the line of union at the point Y, this will sufficiently fasten the sutures. The student is strongly advised to familiarize himself thoroughly with this

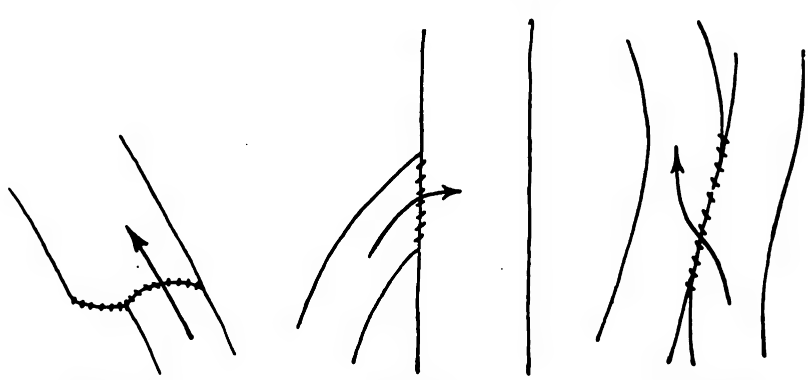


FIG. 539. FIG. 540. FIG. 541.

method before attempting it on the living. An old coat makes a good model on which to practise this operation. Imagine the wrist ends of the sleeves to be open ends of gut, and unite them. A few minutes of such practice with a coarse needle and thread makes easy the comprehension of this rather puzzling stitch.

Remarks on Anastomosis.—In the preceding pages many methods have been described by which union between various segments of the gastro-intestinal canal may be effected for various purposes. The experienced surgeon has no difficulty in making a selection of the method which will serve his purpose

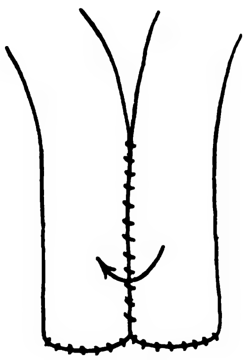


FIG. 542.

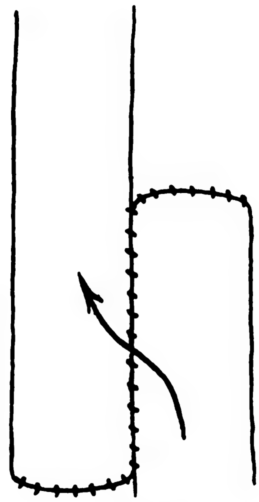


FIG. 543.

best; a hint suffices to equip him for the performance of some modified operation with the details of which he was not previously familiar. With the beginner in operative surgery it is entirely different. He ought to select a general method

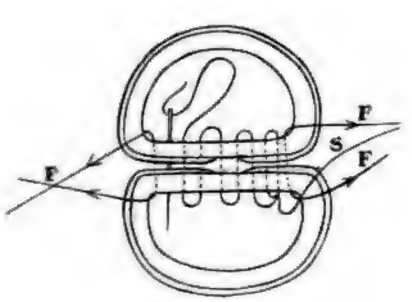


FIG. 544.

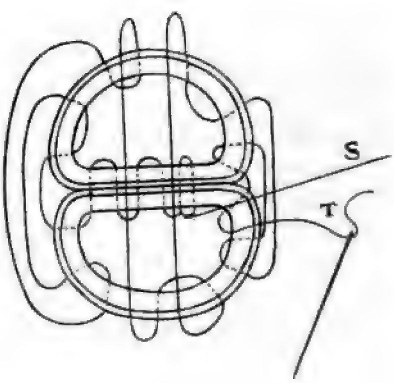


FIG. 545.

FIGS. 544 AND 545.—Connell's suture.

of operating suitable for almost all cases, he ought to practise this method *ad nauseam* on intestines removed from hogs (vivisection is here unnecessary) until he almost can carry out the minutest details with his eyes blindfolded. Having once established for himself a basal or normal method of operating,

excursions into the more refined elegancies of technic become easy and often desirable.

Lateral anastomosis is the most universally applicable method of uniting one segment of gut to the other. It is the basal method of operating and must be mastered in every detail by the surgeon before he presumes to open the abdomen for any purpose, as in the course of the simplest of intra-abdominal operations circumstances may arise which compel interference with the intestinal canal.

The following operations are either identical or almost identical with lateral anastomosis:

A. *Gastro-gastrostomy in Hour-glass Stomach.*—(*a*) Union of the two stomach pouches by a moderate-sized opening. (Identical with lateral anastomosis.)

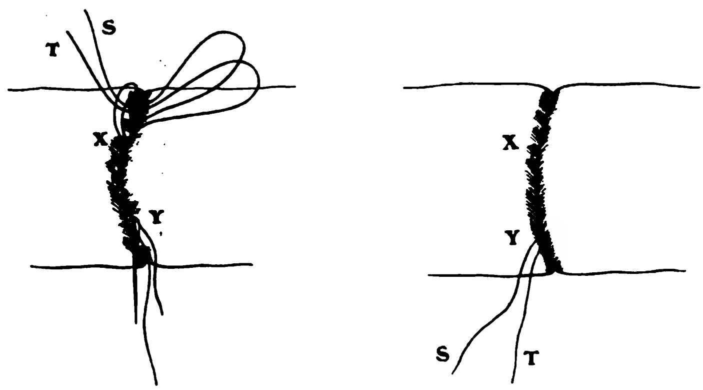


FIG. 546. FIG. 547.
FIGS. 546 AND 547.—Connell's suture.

(*b*) Union of the two pouches with restoration of the normal shape of the stomach. This procedure is practically the same as Finney's operation. (Almost identical with lateral anastomosis.)

B. *Finney's Operation.*—Gastro-duodenostomy. (Almost identical with lateral anastomosis.)

C. *Gastro-enterostomy.*—(Identical with lateral anastomosis.)

D. *Cholecystenterostomy.*—(Identical with lateral anastomosis.)

E. *Entero-enterostomy.*—Lateral anastomosis—indicated after excision of gut (*e.g.*, in gangrenous hernia, tumor, etc.) or for purposes of intestinal exclusion.

F. *Entero-colostomy.*—Lateral anastomosis.

G. *Monari's uretero-ureterostomy* is practically identical with lateral anastomosis.

Resection of a Portion of Small Intestine.—The indications for this operation are localized malignant or benign tumors; localized tuberculous lesions; gangrene; trauma extensive enough to contraindicate local suturing, etc.

The Operation.—*Step* 1.—Open the belly in the middle line.

Step 2.—Pull the affected loop of gut outside the belly and protect the peritoneal cavity with gauze pads.

Step 3.—Empty the contents from the intestinal loop by "stripping" with the fingers. Apply clamps.

Step 4.—Note the blood-supply as it passes through the mesentery. Ligate the vessels supplying the portion of gut to be removed.

Step 5.—Divide the intestine on each side of the disease at a point where it is well supplied with blood (Fig. 548). Section of the gut should be made obliquely, more of the free border being removed than of the mesenteric. This is done: (*a*) because when obliquely divided the open ends of gut have a greater circumference than when cut transversely, and hence allow for the loss of diameter occasioned by suturing; (*b*) because the gut-wall on the non-attached border is more liable to be well nourished. If desirable, excise a V-shaped portion of mesentery corresponding to the segment of gut removed.

Step 6.—Either unite the ends of the gut by an end-to-end anastomosis or close them by means of suture, preferably purse-string, and provide for intestinal continuity by a lateral anastomosis.

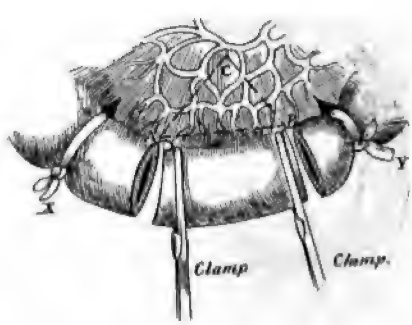


FIG. 548—Enterectomy.

Step 7.—If a V-shaped portion of mesentery has been removed, unite its edges by suture. If this has not been done, fold any redundancy upon itself and secure by a few stitches, being careful not to interfere with the nutrition of the gut. When several feet of intestine have been excised and especially when the mesentery is loaded with much fat it is impossible to suture the mesenteric wound neatly, leaving no raw surfaces. Even after much has been accomplished by suturing it is certain that a larger or smaller mass will protrude from the mesentery and if uncovered by peritoneum will invite adhesion and consequent ileus. When such a raw stump is present, choose a suitable portion of omentum; ligate and cut it off. Spread the omental sheet, thus obtained, over the raw stump and fix it by a few sutures.

Step 8.—Review the wound. Cleanse. Remove gauze pads. Return the gut into the belly. Close the abdomen.

Cæcectomy is indicated in cases of malignant or tuberculous disease, as well as in some cases of intussusception.

Step 1.—Open abdomen in right semilunar line; expose and examine the diseased organs.

Step 2.—Incise the posterior parietal peritoneum at the outer side of the cæcum and ascending colon. Free the cæcum from its bed by finger dissection. Ligate and divide the branches of the ileocolic artery to the necessary extent. Completely mobilize the diseased segment of gut. The cæcum may be so

mobile, *i.e.*, so well provided with mesocæcum, that ligatures or clamps may be applied directly without preliminary dissection.

Step 3.—Treat the mobilized gut as in Paul's colectomy or proceed as follows:

With two crushing forceps applied about 1 inch apart strongly clamp the ileum at a point 6 to 8 inches above the cæcum. Divide the gut between the forceps. Cleanse the cut surfaces.

Treatment of the proximal segment of the ileum: (*a*) With a continuous suture tightly close the open end of the gut (*i.e.*, distal to the clamp); (*b*) surround the gut about 1½ inches proximal to the clamp with a purse-string suture; (*c*) remove the clamp; invaginate the sutured end of the gut and tighten the purse-string sutures. In the same manner with crushing forceps doubly clamp and divide the ascending colon distal to the disease. Remove the diseased segment of gut. Treat the distal segment of colon in the same manner as the ileum.

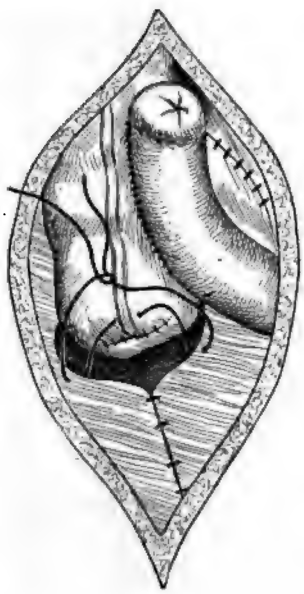


FIG. 549.—Ileum anastomosed to ascending colon.

Peritonealization of wound. Divided ends of ileum and colon closed.

Make a lateral anastomosis between the ileum and the colon or sigmoid.

Repair the wound in the peritoneum (peritonealization) (Fig. 549). To do this it may be necessary to mobilize the parietal peritoneum on both sides of the raw surface left by the removal of the cæcum. Unless the peritoneum is mobilized and freed from the ureter when sutures are inserted and tied, the ureter may be kinked.

Jamison and Dobson ("Lancet," April 27, 1907) have made a very thorough study of the lymphatic system of the cæcum, and as a result recommend the following operation for the removal of a cancerous cæcum.

Step 1.—Open the abdomen in the right semilunar line or through the rectus muscle. Push the omentum and small intestine to the left.

Step 2.—Identify the lower border of the third part of the duodenum and open the posterior parietal peritoneum just below it. Search for and identify the ileocolic vessels (Fig. 550). Instead of attacking the ileocolic vessels from in front it is better to mobilize the cæcum as in Step 2 of the previous operation and so to expose and treat the vessels and lymphatics from behind (Fig. 551).

Wipe downwards the fatty tissue surrounding the vessels, taking great care not to wound the duodenum. Doubly ligate and divide the vessels about 1 inch below their junction with the superior mesenterics. This devascularizes the whole ascending colon.

Step 3.—Select the point for dividing the colon at the hepatic flexure or on

the transverse colon, but do *not* yet divide the gut. From the duodenum to the selected point on the colon divide the peritoneum. At this time some branches of the mid-colic vessels will require attention.

Expose the course of the ileocolic vessels down to the cæcum and appendix by incising the peritoneum. With gauze wipe these vessels and the accompanying chain of glands and fatty tissue, as well at the overlying peritoneum, down to the ileum and cæcum and out to the ascending colon. Identify and avoid the ureter. This dissection is carried so far that the cæcum and colon are completely separated from the body except where they are continuous with the ileum and transverse colon and where they are united to the body by their external peritoneal reflection. Divide this peritoneal reflection. This step may be more conveniently accomplished by incising the peritoneum external to the gut, mobilizing the cæcum by blunt dissection, reflecting the

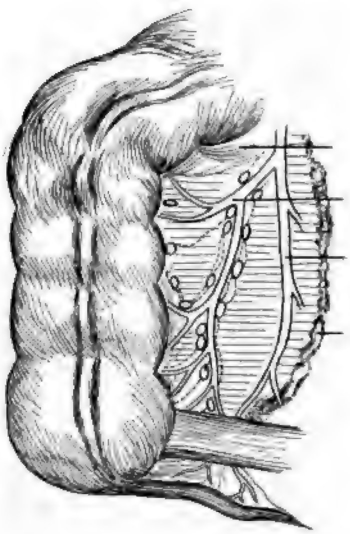


FIG. 550.—Lymphatics and vessels of cæcum.

cæcum and colon inwards and reaching the colic artery and lymphatics from behind (Fig. 551).

Step 4.—Doubly clamp and divide the colon at the selected spot. Do the same to the ileum about 6 inches from its termination. Close the open end of the transverse colon. Close the open end of the ileum and make a lateral anastomosis between the ileum and the remaining colon or the sigmoid. As an alternative method the open end of the ileum may be anastomosed to the side of the colon or sigmoid.

Step 5.—By means of judicious suturing with catgut cover the resulting raw surfaces with peritoneum.

Partial Colectomy.*—The sigmoid or the transverse colon may be removed in the same manner as described under the title "Enterectomy" except when

* For Transversectomy, see p. 426.

the sigmoid is not sufficiently mobile. The ascending and descending portions of the colon are usually well fixed to the parietes and require special treatment. Excision of the ascending colon is practically the same as cæcectomy. The following description applies to the descending colon.

FIG. 551.—Mobilization of cæcum and ascending colon. Note duodenum and ureter exposed. (*Mayo.*)

Step 1.—Open the abdomen in the left semilunar line. Explore. Protect the rest of the abdomen with warm gauze pads.

Step 2.—Incise the parietal peritoneum immediately external and parallel to the descending colon. This incision ought to extend well above and below the level of the disease in the colon. By blunt dissection with finger and gauze it is easy to raise not only the colon from its bed but the colonic vessels as well,

along with the posterior parietal peritoneum, to the inner side of the colon. An artificial meso-colon is thus formed containing the blood-vessels but only covered by peritoneum on one (the inner) side (see Cæcectomy). Be careful to avoid injuring the ureter. Continue mobilizing the colon (if necessary even its splenic flexure) until all the diseased segment can be delivered through

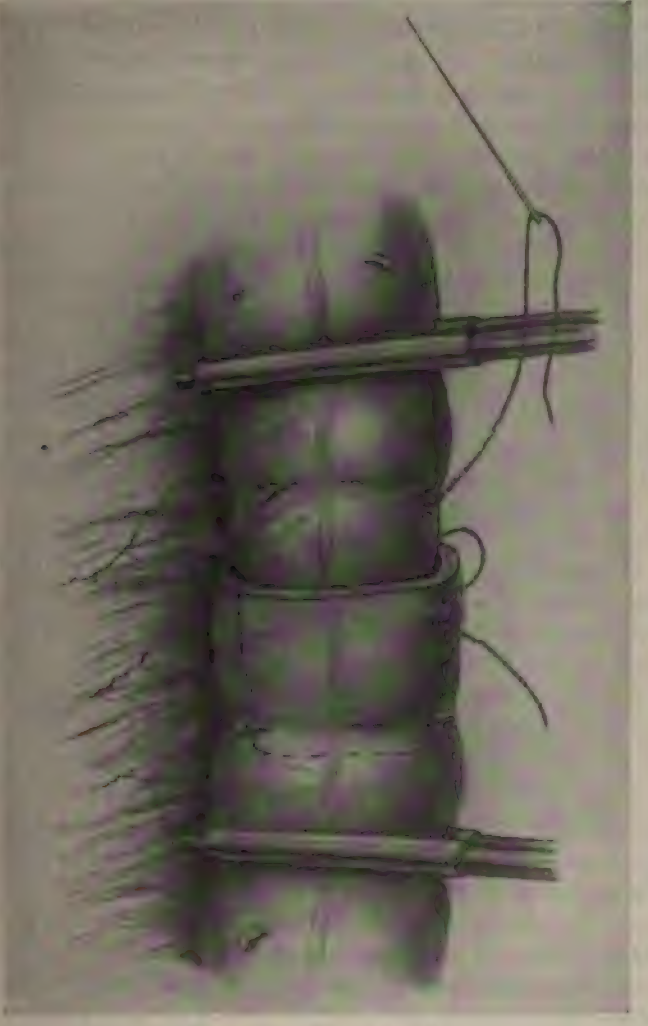


FIG. 552.—(*C. L. Gibson.*)

the abdominal wound without tension. If care has been used in the blunt dissection no harm has been inflicted on the blood-vessels. Bring the diseased segment of gut out through the abdominal wall.

Step 3.—Doubly ligate and divide the vessels going to the diseased segment of gut, thus leaving that segment completely free except for its continuation

above and below. The ligation should be done high up on the vessels so that the lymphatic glands may be reached. The vessels may be tied either from behind after the gut has been mobilized or from in front as may be convenient. Dissect all fat and lymphatic tissue from the site of ligation towards the gut along with those portions of the vessels attached to the gut. Ligation of the vessels near their origin is most important, but it necessarily devitalizes a large extent of bowel and all of the devitalized gut must of course be removed which is really an advantage as ultimate success depends on thorough removal of the disease. Of course in non-malignant disease, *e.g.*, diverticulitis, such extensive resection is entirely unnecessary.

Step 4.—At a safe distance above the disease and the devitalized bowel apply a crushing clamp to the gut, and an inch or an inch and one-half higher up apply an intestinal clamp to the gut. Divide the gut between the clamps and sterilize the stumps with the cautery, carbolic acid or tincture of iodine. Similarly apply clamps (the crushing clamp nearer the diseased segment) below the disease and divide the gut. Remove the diseased segment.

Step 5.—Approximate the divided ends of the intestine. This is usually possible if mobilization has been sufficiently free. Moynihan urges that thorough mobilization of the splenic flexure, without injury to its vascular supply, is often necessary to secure approximation of the intestine after resection.

Method A.—Restore the continuity of the gut by means of Murphy's button or by the ordinary circular enterorrhaphy.

Method B.—C. L. Gibson's method ("Annals Surg.," July, 1910). Seize the upper cut edge of gut with two Kocher's forceps and push it into the lumen of the lower end as far down as possible. Rotate "the upper segment about a quarter circle so that the non-peritoneal surfaces do not entirely approximate in the circumference." Introduce a sufficient number of Lembert sutures as shown in Fig. 552. When tying the sutures tuck in or invaginate the upper edge of the lower segment as shown in Fig. 553.

Method C.—The diseased segment of gut has been delivered and its vessels ligated and divided as in Step 3, but the gut has not been divided. Make a lateral anastomosis between the afferent and efferent loops of gut. Doubly clamp the afferent segment between the anastomosis and the disease. Divide the gut between the forceps. Close with sutures the open end of the gut next the anastomosis; remove the clamp; invaginate the stump by means of a purse-string suture or a line of Lembert sutures. Do the same with the efferent loop. Suture the two stumps to the parietal peritoneum.

Method D.—If it has been necessary to remove the splenic flexure along with the descending colon, close the open ends of the gut and make a lateral anastomosis between the transverse and the remnant of the descending colon or the sigmoid. If the whole colon and cæcum have been excised perform ileosigmoidostomy.

Method E.—Stephen Fenwick (Trans. R. Soc. Med. Surg. Sect., VII, No. 5) after excising a tumor of the sigmoid along with a **V** of mesentery found that an interval of about 3 inches existed between the segment of gut to be united,

even after he had pulled the rectum up as far as possible. To fill the gap he selected a convenient loop of ileum about 5 inches in length, applied two intestinal clamps at each end of this loop, divided the gut between the clamps and carried the incisions up the meso-ileum between its vessels. He next united the proximal and distal segments of ileum by end-to-end anastomosis, and implanted the mobilized segment of gut, by means of two medium-sized Murphy buttons, to fill the defect in the sigmoid. The holes in the mesentery were carefully sutured. Recovery took place in spite of various complications. The bowel action was satisfactory and in three years there was no recurrence.

Step 6.—Repair the wound in the peritoneum. Close the abdomen.

FIG. 553.—(*C. L. Gibson.*)

Partial Colectomy in Two Stages.—*Steps* 1, 2, and 3 as in the preceding operation.

Step 4. *Method A.*—Exactly as in Step 5, method C of preceding operation, make an anastomosis between the afferent and efferent loops of gut but do not yet excise the disease. Partially close the abdominal wound around the protruding intestine. Apply dressings.

Method B.—Deliver the diseased segment of gut. Unite with sutures the afferent to the efferent loops as they pass through the abdominal wall. Partially close the abdominal wound.

In both methods A and B the diseased segment of gut is excised after the lapse of from 12 to 48 hours. No anesthetic is usually necessary while removing the disease but bleeding is usually very free requiring many ligatures or sutures

to be applied to the mucosa and submucosa. The result is of course a fecal fistula which may be closed later.

Method C.—(Paul's Colectomy.) Sew together the healthy segments of gut as they pass through the abdominal wound. Make an incision into the prolapsed gut above and below the disease. Into each intestinal opening pass a glass tube (Paul's, Mixter's) and ligate it there, Fig. 554. Cut away the diseased portion of gut. Partially close the wound. Apply dressings.

Complete Colectomy.—The transverse colon may be removed in the manner described under the title "Enterectomy," hemostasis being effected by a chain of ligatures applied to the transverse mesocolon and the great omentum between the stomach and colon. This method necessarily sacrifices the great omentum and leaves clumsy stumps which it is difficult to peritonealize satisfactorily.

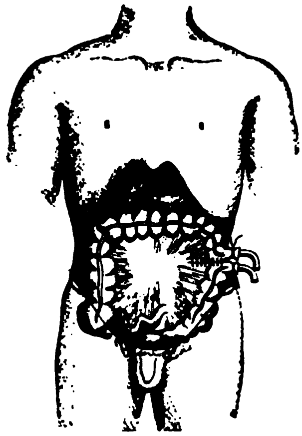


FIG. 554.—Paul's colectomy. (*Maylard.*)

The writer has found the following operation devised by Lardennois (Journ. de Chir., June, 1914) to be unexpectedly easy while by it the omentum is saved, hemostasis is simplified, clumsy stumps are avoided and if mobilization of the hepatic and splenic flexures is necessary such is easily accomplished.

Step 1.—After opening the abdomen and making a thorough exploration, pull the great omentum and transverse colon out of the abdomen and reflect them upwards. If *slight* traction is made upwards in the omentum and downwards on the colon numerous delicate peritoneal folds will be seen passing from the omentum on to the colon (Fig. 555.) Divide some of these folds carefully close to the gut and begin separating the omentum from the colon with scissors, guided by the finger, introduced through the original cut. Often during this dissection the operator will think he has button-holed the omentum but usually his fears prove baseless but if this accident has occurred it is not of much importance unless a very large hole has been torn. Continue the separation of the omentum upwards until not only the colon but the transverse mesocolon as well, lie free from the omentum which is reflected upwards out of the way. Unless mobilization of the flexures is necessary or total colectomy is indicated proceed to Step 3.

Step 2.—Mobilization of the ascending and descending colon. Placing the finger flatly on the mesocolon burrow towards the left under the suspensory ligament of the splenic flexure and divide this avascular peritoneal band. This detaches the splenic flexure more easily than is possible by any other means. Retract the descending colon upwards and continue the incision which mobilized the flexure, downwards through the parietal peritoneum close to its reflexion on to the descending colon and with the finger separate the colon from its bed. This mobilization of the descending colon and its vessels may be carried out freely even to a point not far from the middle line. In a similar manner the

hepatic flexure and the ascending colon may be mobilized, care being taken to avoid injuring the ureter.

Step 3.—Return the great omentum into the abdomen. Lift the colon into the air so as to spread out its meson and make its blood-vessels clearly visible. If the transverse colon alone is to be excised, doubly clamp the vessels passing to that part of the gut, divide the meson between the clamps, excise

FIG. 555.—Separation of omentum from transverse colon. (*Lardennois, Journ. de Chir.*)

the desired portion of intestine and restore intestinal continuity by a lateral or preferably, an end-to-end anastomosis. If a more complete colectomy is necessary it is easy to assure exact hemostasis by applying ligatures to the middle and right colic arteries near their origin, and to the left colic vessels at such points as will not endanger the vitality of the gut which is to be retained. Divide the meso-colon along the line shown in Fig. 556.

Step 4.—The whole colon is now free except for its continuation into the cæcum and sigmoid.

Place the patient in Trendelenburg's position so that the small intestines can be kept out of the way.

Choose the point of section on the pelvic colon. Crush the gut with forceps (Doyen's; Payr's) and apply a silk ligature tightly in the groove left by the forceps. Apply a strong clamp to the gut a little above the ligature. Divide the gut with a cautery between the ligature and the clamp and place the clamped

FIG. 556.—(*Lardennois, Journ. de Chir.*)

(upper) end of the gut away from the field of operation. Insert a purse-string suture around the distal (ligated) segment of gut and invert the stump. Instead of removing the Payr's clamp one may cut between it and the clamp on the upper segment of gut, with a cautery, being careful to destroy all the tissue between the two clamps and to thoroughly sear or desiccate the tissues crushed between the blades of the Payr's clamp (distal segment of gut). Keeping the clamp *in situ* insert a continuous suture of silk, the alternate stitches being on opposite sides of the clamp (Fig. 557) and the loops of the thread passing over

ıe clamp. Remove the clamp. The crushed and burned edges of the wound dhere together so that there is no danger of the lumen of the gut opening r of bleeding occurring. Traction on the two ends of the silk suture causes ı neat and thorough invertion of the wound. Fix the ends of the suture and insert a second row of sutures.

Step 5.—Mobilize the cæcum and lower end of the ileum as in cæcectomy. Ligate the ileocolic artery at an appropriate point. Choose the site for dividing the ileum. Immediately distal to this site apply a crushing forceps (Ochsner's forceps) to the ileum. Above this line of section apply a reliable intestinal forceps. Divide the gut close to the crushing forceps. This completes the excision of the colon.

Step 6.—Implant the end of the ileum into the side of the pelvic colon.

Step 7.—Review the wound left by the removal of the colon and cover all raw surfaces with peritoneum.

Lane at this stage of the operation has an assistant pass a rubber tube through the anus and the surgeon guides it through the anastomotic opening. Such direct drainage of the small intestine for a few days is distinctly valuable.

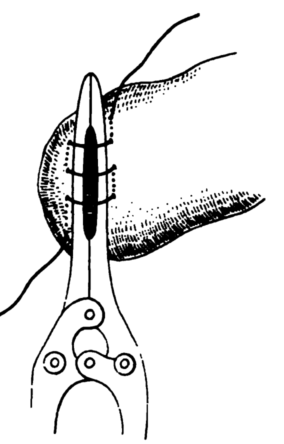


FIG. 557.

Subcæcal Colectomy.—If it is justifiable to preserve the cæcum when a colectomy is indicated Lardennois thinks it is very advantageous to do so, as one then saves the very active terminal ileum, the ileocæcal valve and the cæcum itself where valuable digestive processes take place.

The Operation.—Mobilize the colon and divide its mesenteries as in total colectomy but do not yet interfere with the cæcum. Choose the site of section in the ascending colon. Apply a crushing clamp (Payr's) to the cæcal side of the line of section and a strong Ochsner's clamp to the distal side. Divide between the clamps with a cautery. Lay aside (well protected) the clamped distal segment of gut. Apply a continuous silk suture to the clamped cæcum by means of which the wound is closed and inverted when the clamp is removed exactly as the pelvic colon was treated in complete colectomy. Choose a portion of the sigmoid which can be brought without tension into apposition with the blind fundus of the cæcum. At this site apply two clamps to the sigmoid (a crushing clamp above, an intestinal clamp below) and divide the gut between these clamps. The resected portion of the colon is now removed. Apply an intestinal clamp to the fundus of the cæcum. Anastomose the end of the sigmoid to the fundus of the cæcum. The appendix ought, of course, to be removed. Obliterate all openings through which a loop of small intestine might penetrate and give rise to obstruction.

Lane's Colectomy.—Lane in performing colectomy makes no endeavor to ... the omentum. After opening the abdomen his first endeavor is to separate "evolutionary adhesions" from the mesenteries without injury to the latter

structures. This greatly facilitates the removal of the bowel and as little or none of the mesentery is denuded of its peritoneal covering the risk of dangerous adhesions to the small intestine is lessened. In ligating the vessels no large masses of mesentery should be included. "It is well to remember that one of the chief immediate risks of the operation is hemorrhage, which may result either from the escape of a vessel from the ligature in a fat subject, or from the friability of the ligatured vessels in a thin toxic one." The ileum is divided as in ileo-colostomy. The pelvic colon is drawn up out of the pelvis and grasped with two pair of forceps (Oschner's) about 2 inches above the pelvic brim. The end of the ileum is attached directly to the cut end of the pelvic colon by the usual method of end-to-end anastomosis. When the circumference of the colon is considerably greater than that of the ileum if the stitches in the wider gut are inserted more widely apart than in the narrower gut then a secure union is easily obtained.

FIG. 558.—Cæcopexy.

The cut edges of the ileal and colonic mesenteries must be carefully united by suturing both the upper and lower aspects of their junction. Lane finds the end-to-end anastomosis preferable in every respect to the lateral or end-to-side.

In the treatment of intestinal stasis Lane considers colectomy the operation of choice. He also prefers it to any partial operation in obstruction due to mobile colonic tumors and in megalo-colon.

Cæcopexy.—Wilms' Method. *Step* 1.—Open the abdomen by a right rectus incision. As a matter of routine remove the appendix. Select a site in the iliac fossa against which the cæcum can be placed without the production of any kinking in the colon or ileum.

Step 2.—Reflect a flap of peritoneum from the iliac fossa. Place the caput coli on the raw surface thus prepared and suture the peritoneal flap over the cæcum, Fig. 558.

Step 3.—Close the abdomen.

Quenu and Duval's Method (Rev. de Chir., May 10, 1914).—Place the patient in Trendelenburg's position. Open the abdomen in the ileo-cæcal region. Examine the cæcum. If the mobile cæcum is too long or dilated, lessen its size by transverse or longitudinal plication or by both. Introduce a retractor and expose the whole iliac fossa. Recognize the right iliac artery and make an incision through the iliac peritoneum external and parallel to the vessel. This cut extends from the middle of the iliac fossa to the posterior point of fixation

FIG. 559.—(*Roeder*.)

of the cæcum in the lumbar region. If the colon is now slightly freed from its bed by dissection it is advantageous. Through the peritoneal incision expose the tendon of the psoas parvus muscle, or if this is absent, the internal border of the psoas, in which case it is necessary to retract the artery inwards to permit suturing. Introduce three or four non-absorbable sutures through the tendon of the psoas parvus and then through the posterior longitudinal cæco-colic band. When these sutures are tied the cæcum is well anchored in the iliac fossa. Suture the edges of the incision in the iliac peritoneum to the head of the cæcum.

Cæcopexy plus Cæcoplication.—Roeder ("Journ. A. M. A.," Feb. 25, 1911) introduces a number of sutures (hemp or silk) into the outer side of the cæcum in the manner shown in Fig. 559. The last bite of the stitch is in the parietal peritoneum just external to the root of the meso-cæcum. The number of bites

each stitch takes in the gut is regulated by the amount of dilatation present. The number of stitches used is of course in proportion to the length of intestine to be plicated and anchored.

DIVERTICULITIS

The papers of Cahier ("Rev. de Chir.," September 19, 1906), Brewer ("Amer. Journ. Med. Sc.," October, 1907), Mayo ("Surg. Gyn. and Obstetrics," July, 1907) and others have attracted attention to a condition named acquired diverticulitis. A few words explanatory of the disease may assist the operator. Acquired or false diverticula are simple herniæ of the mucous and submucous tunics through the circular muscular coat of the descending colon and sigmoid at points where the musculosa happens to be weak. Chronic leakage may take place through the diverticular walls and give rise to large inflammatory deposits. The result of the inflammation may be: (1) Abscess. This requires free drainage. (2) Acute local infection *plus* acute obstruction. This requires free drainage *plus* the establishment of an artificial anus. Subsequently, if necessary, the diseased segment of colon may be excised. (3) Chronic obstruction with inflammatory tumor but no abscess. This form is usually mistaken for malignant disease. The treatment is resection of the involved segment of gut.

INTESTINAL EXCLUSION OR SEGREGATION

Exclusion on Segregation of Intestine.—In some cases where, from extensive adhesions or from other causes, it seems impossible or improper to excise a certain segment of gut, good results may be obtained by protecting it from the irritations incident to the performance of its physiological functions. In this way fæcal fistulæ may be induced to close and some neoplasms may develop less rapidly. The operation which is used for this purpose may be named "*exclusion of the intestine.*" Tuberculous lesions of the intestine, unless fairly easy of excision, may well be treated by exclusion.

Ileo-colostomy.—Ileo-sigmoidostomy.—Lane's Method.—*Step* 1.—During the administration of the anesthetic begin the hypodermic administration of salt solution in both axillæ and keep it up during the operation. Six or more pints may be given.

Step 2.—Open the abdomen by a suitable vertical incision to the left of the middle line so as to divide the sheath of the rectus twice and thus obtain a secure abdominal scar.

Step 3.—Pick up the ileum and apply two Ochsner (crushing) clamps to it, close together, about 6 inches from its termination. Divide the gut between the forceps by means of a cautery thus completely sterilizing the stumps of the gut. Close the distal aperture by means of a running suture applied before and tightened during removal of the clamp. Invaginate the closed stump by means of a purse-string suture exactly as an appendix stump is invaginated.

Step 4.—At a convenient distance from the crushing clamp apply an intestinal clamp to the proximal segment of ileum and anastomose its ends to the side of the upper part of the pelvic colon using the usual two rows of suture. Should the junction appear insecure at any point, owing to tenuity of the ileal wall, to inflammatory changes in the pelvic colon or to the abundant deposit of fat in the colonic peritoneum, reinforce with extra stitches.

Step 5.—Draw the intestines out of the pelvis. Very carefully sew the adjacent surface of the pelvic colon to the divided margin of the mesentery of the ileum. This is so important that it is wise to suture not merely the upper but also the lower aspect of the junction, otherwise internal hernia may result or the constant pressure of the small intestines may cause separation of the mesenteries and lead to trouble or disaster.

Step 6.—Examine the fixation of the sigmoid to the pelvis. If what Lane calls the "last kink" is tightly fixed at the brim of the pelvis nothing need be done to it; but if it is not so fixed, sew the bowel and mesentery very securely to the brim so as to reduce the tendency to the regurgitation of fæces up into the iliac colon.

Step 7.—Have an assistant pass an œsophageal tube through the anus into the pelvic colon and guided by the fingers of the surgeon, through the anastomosis into the ileum for a distance of about 8 inches. (The tube should be secured to the anus by a stitch). "If any difficulty is experienced in passing the tube, a quantity of paraffin is injected through it which materially facilitates its introduction. This tube prevents the accumulation of gas in the small intestines, and permits of the free passage of the fluid contents through the junction, and their collection in a vessel beneath the bed."

Step 8.—Introduce two or more pints of warm saline solution into the peritoneal cavity in an endeavor to prevent the formation of adhesions (to reduce this risk still further the patient is moved from side to side at frequent intervals during the after-treatment). Close the abdominal wound.

In the treatment of "Intestinal Stasis" Lane recommends ileo-colostomy highly when the preferable operation of colectomy seems too dangerous. When colectomy is proper its immediate risk is less than that of ileo-colostomy and the convalescence is much less stormy.

In the belief that chronic intestinal stasis is *the* predisposing cause of tuberculosis of the bones and joints, Lane begins treatment of these lesions by performing ileo-colostomy.

An operation along the lines of ileo-sigmoidostomy seems to be the best treatment for idiopathic dilatation of the colon (Hirschsprung's disease). It must be remembered, however, that the hugely distended sigmoid colon may subsequently give rise to volvulus. In at least one case, even after much of the sigmoid was excised for volvulus, the remnant of sigmoid between the anastomosis and the rectum became hugely dilated and once more occasioned volvulus. Mr. Makins corrected the position of the loop and fixed it with good effect (Hawkins, "Brit. Med. Journ.," March 2, 1007).

Yeomans ("Am. Journ. of Surg.," Jan., 1913) recommends cæco-sigmoidos-

28

tomy instead of ileo-sigmoidostomy in suitable cases as by it a more thorough drainage of the segregated or excluded colon can be obtained.

Cæco-sigmoidostomy.—Typhlo-sigmoidostomy.—Put the patient in the Trendelenburg position.

Open the abdomen by a free median, rectus or transverse incision. Explore the abdomen.

Push the small intestines out of the way and protect them with moist pads.

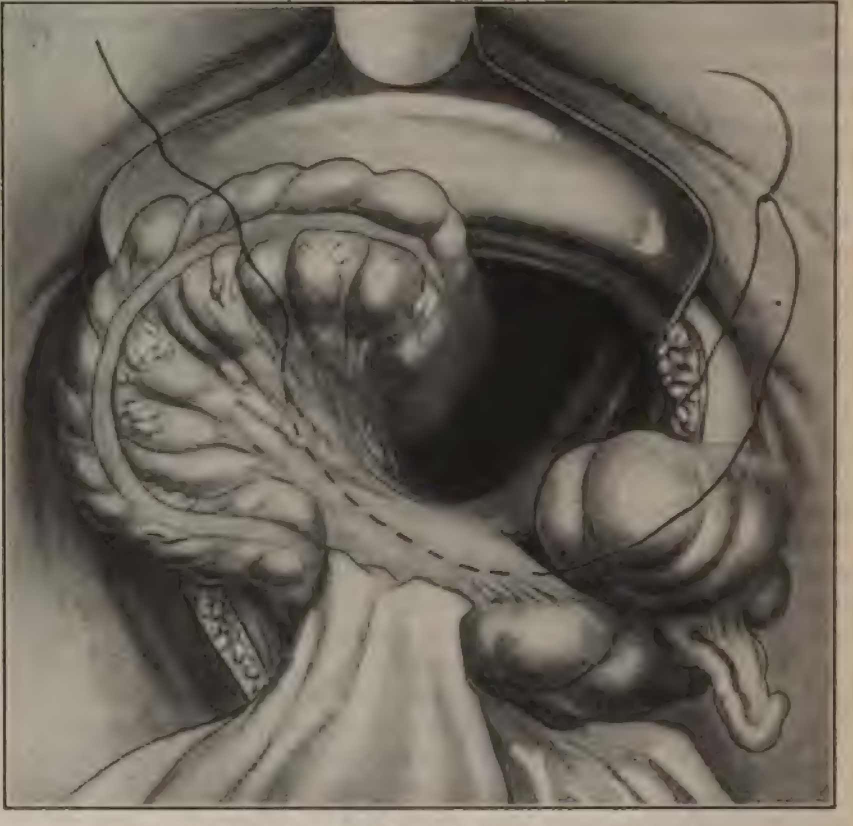


FIG. 560.—(*Lardennois and Okinczyc, Journ. de Chir.*)

If the cæcum and sigmoid are easily apposed proceed with the operation. If immobility of the cæcum impedes approximation, mobilize it by incising the parietal peritoneum along its outer and lower border and raising it as in cæcectomy. Beware of injuring the ureter. If the sigmoid is immobile divide the peritoneum forming the external or inferior layer of its meson and mobilize it exactly as the descending colon is mobilized in colectomy but carefully avoid injury to the vessels.

With a fine curved needle introduce the suture A B, Fig. 560 (Lardennois, and Okinczyc, Journ. de Chir., May, 1913, p. 542). This stitch involves the

upper or inner layer of the meso-sigmoid, the median parietal peritoneum and some of the undersurface of the meso-ileum. It is easy to avoid injury to vessels if one picks up the parietal peritoneum with forceps before introducing the needle at any point. Apply a hemostat to each end of the stitch and put it aside.

Remove the appendix. Make an anastomosis between the blind end of the cæcum and a convenient part of the sigmoid. When the anastomosis is complete tighten and tie the suture A B, and so prevent the possibility of a peritoneal lacuna being formed behind the anastomosis with its dangers of internal hernia.

Some surgeons *complicate* the operation as follows: Choose a portion of the pelvic colon as low down as practicable and there divide the gut between intestinal forceps. Anastomose the open end of the proximal loop of colon to the side of the distal segment. Anastomose the open end of the distal segment to the blind end of the cæcum.

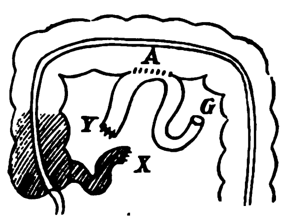


FIG. 561.—Unilateral exclusion.

In the following description it is assumed that the cæcum and adjacent segment of ileum are diseased and require to be segregated.

(A) *Unilateral Exclusion.—Step* 1.—Open the abdomen in a suitable position. Examine the diseased structures.

Step 2.—Find, empty, and doubly clamp the afferent segment of gut, *i.e.*, the portion of healthy gut which passes into the diseased segment. Divide the gut between the clamps. Close each end of the gut by a row of through-and-through sutures covered by a row of continuous Lembert sutures. If desired the purse-string suture may be employed (Fig. 561, X, Y).*

Step 3.—Make an anastomosis between the afferent loop of gut and the colon in a suitable place (Fig. 561, A).

Step 4.—Close the abdomen.

The effect of unilateral exclusion is that while the contents of the excluded segment drain into the colon, no material from the ileum passes into it—in fact, a short circuit is established.

(B) *Bilateral Exclusion.*—This method is proper only when a fistula leads from the skin into the segment to be excluded. The only difference between the bilateral and the unilateral operation consists in the division and suture of the [illegible] distal to the disease and proximal to the anastomosis (Fig. 562).

(C) *Bilateral Exclusion with Drainage of the Excluded Segment.* Here no [illegible] the diseased segment. The operation is identical with that of bilateral exclusion up to the point where the [illegible] is divided. Now instead of [illegible] of the colon at the [illegible] the distal segment [illegible] Fig. [illegible] X [illegible] and permits [illegible]

* [illegible] has [illegible]
ing [illegible]
tion [illegible] will burst [illegible]
operation [illegible] the author [illegible]
has [illegible]

Vautrin thinks and has proved that drainage from one end of the excluded segment of gut is only sufficient if the disease is of comparatively limited extent. Where the disease is extensive and the gut to be drained is more or less coiled, then both ends of the segregated segment should be united to the skin at convenient points; if necessary, special openings being made through the belly-wall. This permits of thorough drainage and lavage, whereby the diseased gut lumen may be kept clean and ulcerations may receive local treatment.

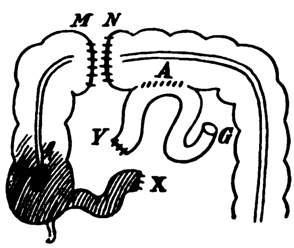


FIG. 562.

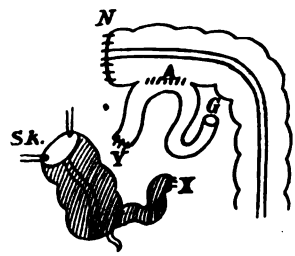


FIG. 563.

FIGS. 562 AND 563.—Bilateral exclusion with drainage.

INTESTINAL OBSTRUCTION

Whichever form of obstruction is present and demands operation, there are certain points common to the treatment of all of them, and which will be considered here.

Before assuming that true obstruction is present it is of vast moment to examine the urine. In the opinion of Paul Delbet ("La Presse Med.," Aug. 24, 1907) the possible existence of constipation in the course of uremia is most important because if one considers that uremia may long remain latent; that it may provoke as its first symptoms, gastric intolerance with vomiting first alimentary then bilious; that there may be a subnormal temperature and a slackening of pulse, one can understand that constipation accompanied by these symptoms may give the appearance of true intestinal obstruction to a complaint which is entirely non-surgical.

As a matter of routine, the rectum must be explored; the omission to do this has too often led the surgeon to operate unnecessarily or to miss the aid of valuable information when operating.* There is often not much time in which to prepare the patient. Enemata will almost certainly have been used before the question of operating has been decided, and hence the lower gut is empty. It is wise to clean out the stomach with the stomach-tube. When there are great nervousness and depression, a small dose of morphine has a quieting and steadying effect which outweighs any ill which it may do. Usually the abdomen is opened in the middle line below the umbilicus. Through this opening any obstruction may be reached and treated.

* Mackenzie ("Brit. Med. Journ.," June 20, 1906) maintains that violent pain (peristaltic) across the middle of the abdomen, *not* below the umbilicus, signifies that the site of the obstruction is in the small intestine while hypogastric pain means that it is in some part of the large intestine.

How to Find the Point of Obstruction.—Theoretically one might proceed, as is usually advised, in the following methodical manner: Pass the finger or hand into the right iliac region and palpate the cæcum. If the cæcum is distended, pass the hand along the colon, as the obstruction must be lower down. If the cæcum is not distended, the obstruction must be in the small intestine. Find a segment of gut which is not distended. Trace the mesentery of the loop of gut under examination to its origin from the spine and find which is its upper surface. Remember that the right layer of the mesentery is also its upper layer. Having found the upper or right surface of the mesentery, that portion of gut which goes to the left is the upper segment, and if followed will assuredly lead to the point of obstruction. Trace the gut up to the point of obstruction, but do *not* let the intestines come out of the belly cavity.

But the belly-walls are generally tense, the intestines are ballooned with gas, the transverse colon is pushed up under the diaphragm, and to carry out the methodical examination described would be very hazardous, even if possible. Greig Smith gave excellent advice as to finding the obstruction. He noted that wherever the obstruction is located it is probable that the most dilated coils will rise to the surface; and, the greater amount of bowel being within three inches of the umbilicus, it is probable that the most dilated coils will be within sight. Very gently move the coils from side to side and up and down, and fix on the most dilated coil, which will be at the same time the most congested. Follow this coil in the direction of increasing distention and congestion. "It will certainly lead to the stricture. The whole manipulation may be carried out with two fingers." If this method fail, Greig Smith recommended to let the most distended coil escape from the belly, protected by a large pad. One end of the coil escapes less readily than the other and appears more congested; this end of the coil will lead to the obstruction.

When the intestines are very much distended with gas, there are certain dangers to be feared and combated during the operation:

1. During the necessary manipulations the pressure of the fingers or hand may cause rupture of the gut.

2. If rupture is avoided and the direct cause of obstruction relieved, the ballooning of the gut may cause kinking or valve formation of individual loops and so prevent emptying of the bowel.

3. Prolonged overdistention so paralyzes or weakens the intestinal muscles that they are unable to contract.

4. The operation being completed, it may be impossible to close the abdominal wound over the dilated intestines.

Greig Smith held that "no operation for intestinal obstruction is properly completed if the patient leaves the operating-table with a greatly distended abdomen."

Dahlgren ("Centralblatt f. Chir.," April 15, 1905), after incising the intestine, "milks" it throughout its whole length, using gloved hands or a special instrument consisting of two cylinders like bobbins held together by a spring. This he finds specially useful in general peritonitis with intestinal paralysis.

In ileus without mechanical obstruction he finds atropin sulphate hypodermically, 1 milligramme repeated, of great value. He began using the atropin without faith as a last resort, but has learned its value (has given 5 to 7 milligrammes in twelve to fifteen hours).

After the direct cause of the obstruction has been located and treated, or, if more convenient, before that is done, permit one of the most distended loops of gut to protrude from the belly. Protect the abdominal cavity with hot pads or soft towels. Make an incision into the gut (either transverse of longitudinal) and encourage its contents to escape into a suitable vessel. When the contents cease to escape, clean the wound and close it with a continuous Lembert suture. If necessary, repeat this procedure on other distended loops.* A practical detail which may be of value in carrying out the above is to have a competent assistant assigned to incise, clean and close the gut, and that for his work he should be provided with instruments, sutures, and sponges entirely separate from those used by the operator. The object of this detail is, of course, that the operator and his first assistant may avoid soiling their hands. The use of rubber gloves which can be changed is of much value.

Before closing the last of the *enterotomy* wounds one may, through it, introduce into the gut an ounce of sulphate of magnesia in solution, or one may inject the solution into the gut by means of a syringe with a suitable cannula, subsequently closing the puncture with one or more stitches.

When operating for ileus particularly following pelvic inflammations and appendicitis, an obstruction is often found affecting the ileum not very far from the ileo-cæcal junction. After removing this obstruction it is well to examine the sigmoid or pelvic colon as not infrequently there is also an obstruction present where that gut passes the brim of the pelvis (Ileus Duplex, Sampson Handley, Lancet, May 1, 1915).

If the patient is very much collapsed or if it is difficult to find and treat the direct cause of the obstruction, the surgeon should throw aside all ambition to do a complete operation and content himself with bringing the most distended coil of intestine into the abdominal wound and fixing and opening it there (enterostomy). If the patient's strength is equal to the strain, it may be well to precede the enterostomy by evacuating the gut at several places in the manner already described, as the intestine may refuse to empty itself through one opening.

Very many lives have been saved by means of enterostomy which would have been sacrificed had a more complete operation been attempted. When sufficient strength has been gained, the patient must be submitted to a second and radical operation. It must be remembered that death from obstruction is practically always due to intestinal intoxication. Clairmont and Ranzi found that while the filtrate from the contents of the normal intestine produced no harmful effects when injected into animals, a similar filtrate prepared from the contents of a loop of strangulated bowel produced serious and often fatal results

* This evacuation is by no means always required. It should be done only if distension is so great that the gut will probably be unable to empty itself in the natural manner.

when injected. When obstruction of the large intestine below the cæcum is *complete*, by far the best results are to be obtained from the formation of an artificial anus which may be closed later. When the obstruction is actually at the ileo-cæcal valve and it is necessary to open the small bowel, Paul prefers an

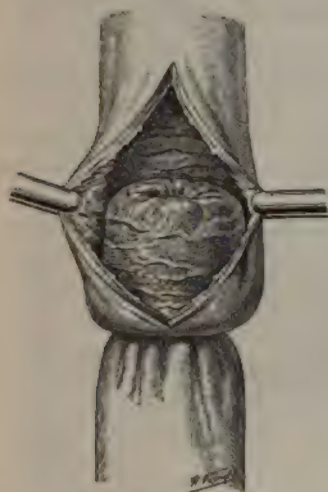


Fig. 564.

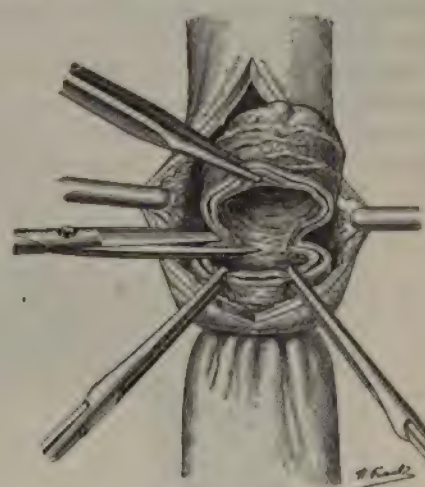


Fig. 565.

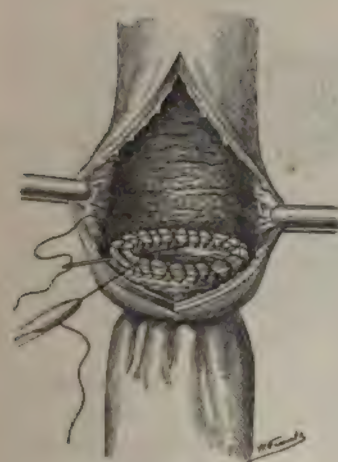


Fig. 566.

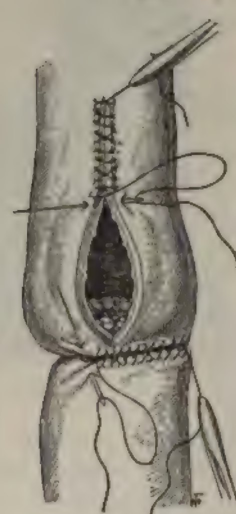


Fig. 567.

Figs. 564 to 567.—Intussusception. (*Guibe.*)

anastomosis because "there are such decided objections to a fæcal fistula connected with the small intestine, and usually such favorable prospects for short circuiting in this situation, that the additional immediate risk may be accepted unless paresis and collapse have already supervened, when an artificial anus is imperative."

If the complete obstruction is known to be in the large intestine distal to the cæcum and is not due to a twist in the sigmoid then a simple right *lumbar* colostomy is the operation of choice. The artificial anus is only intended to be temporary and its posterior position is out of the way when laparotomy is performed later to treat directly the lesion causing the obstruction (Paul, "Brit. Med. Journ.," July 27, 1912).

Intussusception.—Open the abdomen. Discover the site of the obstruction and attempt to reduce it.

Reduction of the Intussusception.—With the fingers of one hand gently grasp the entering bowel close to the invagination; with the other hand take hold of the

FIG. 568.—Intussusception. (*Coffey, Annals of Surgery.*)

bowel immediately below the intussusceptum and gently press, stroke, coax, or milk the intussusceptum upwards. *Make no traction or massage.* If reduction is obtained, examine the involved gut most carefully, lest it should be injured. If an elongation of the mesentery seems to have had anything to do with the production of the intussusception, it is easy to shorten it by throwing it into folds and inserting a few stitches. If this is done, be careful *not* to interfere with the free passage of blood to the gut through the mesentery. If reduction is impossible, and it frequently is, several methods of treatment are possible:

1. Excision of the portion of gut involved. The operation is identical with the enterectomy described elsewhere, and is only permissible when the intussusception is limited in extent.

FIG. 569.

2. Intussusception withdrawn. 3. Pack in distal end gut. 4. Circular incision of middle layer intussusceptum. 5. Forceps on vessels. 6, 7. Ileum divided between clamps. 8. Completion of primary incision. (*Coffey, Annals of Surgery.*)

FIG. 570.

9. Partial suture distal and ileum. 10. Mesentery ligated. 11. Division of mesentery. 12. Proxima gut closed. (*Coffey Annals of Surgery.*)

2. Excision of the intussusceptum. (Figs. 564, 565, 566, 567 explain the operation fully.)

R. C. Coffey in a remarkable paper on intussusception ("Annals of Surgery," January, 1907) recommends the following operation: After exposing the affected gut by laparotomy make the primary incision (Fig. 568) into the intussuscipiens. Withdraw the intussusceptum and wrap it in gauze (Fig. 568). Pack the distal end of the intestine with gauze (Fig. 568). Cut the middle layer of the intussusceptum by a circular incision (Fig. 569). Catch any bleeding points with forceps (Fig. 569). Doubly clamp and divide the healthy intestine (Fig. 569 and Fig. 570). Complete the primary incision, laying open the distal end of the ileum and freeing the intestine to be removed (Fig. 569). Close the distal end to the gut with sutures (Fig. 570). (Coffey advises making this closure only partial so as to anastomose the proximal segment of the ileum to it. It will probably be better to close the gut entirely and make a lateral anastomosis.) Ligate the mesentery (Fig. 570). Divide the mesentery and remove the gangrenous gut (Fig. 570). Close the proximal end of the ileum (Fig. 570). Make an anastomosis between the proximal and distal segments of ileum.

K. Israel impressed by the dangers of soiling the peritoneum during excision first delivers the intussuscipiens, sutures its serous coat to the parietal

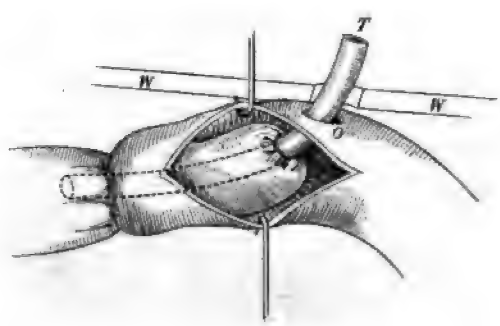


FIG. 571.—Intussusception.

peritoneum, then opens it and excises the intussusceptum as above. He advises this method in all types of intestinal stricture producing a temporary artificial intussusception as in Maunsell's operation.

3. Ellsworth Eliot, Jr., suggests that the affected portion of gut be brought near the abdominal wound; a small incision (O) (Fig. 571) be made near the end of the intussusceptum through the gut wall just below the lesion; a soft catheter (T) be passed through this wound and through the canal of the intussusceptum into the gut above; the incised gut be sutured to the parietal wound (W) (Fig. 571). The result is an artificial anus below the obstruction, preventing increase of the intussusception and providing intestinal drainage through the catheter. Eliot thinks the method may be of use in the case of young children. It is only mentioned here as a suggestion.

4. Instead of enterectomy, the operation of segregation may be employed, r an anastomosis may be established between the open gut above and below e lesion.

5. Under certain circumstances, *e.g.*, prostration, etc., it may be wise to ake an artificial anus, whether accompanied by excision of the intussuscep-ion or not. The prognosis must always be bad when the intussusception is unreduced, even though the continuity of fæcal circulation is provided for, gangrene or inflammation of the involved intestine is liable to occasion a al peritonitis.

The vital importance of early operation in intussusception is clearly demon-ted by Clubbe's statistics. ("Brit. Journal Children's Diseases," July, 09.) During the year 1908 there were thirty-three cases of intussuscep-n treated in the Royal Alexandra Hospital for sick children in Sydney h only two deaths. During the same period Clubbe himself treated twenty-cases without a death. These remarkable results Clubbe attributes to the ly diagnoses made by the physicians who first saw the cases. None of the ients were seen by him later than fifth-three hours from the beginning the trouble. In his opinion laparotomy constitutes the only treatment. bbe's total experience consists of 157 operations for intussusception with e following striking results: Of the first fifty patients twenty-five died, *i.e.*, per cent.: of the second fifty patients twelve died, *i.e.*, 25 per cent.; of the ird fifty patients four died, *i.e.*, 8 per cent.; of the last seven patients none d, *i.e.*, 0 per cent.

The stomach may become twisted on itself, the axis of the twist correspond-g more or less to the lesser curvature. Gastric volvulus may be:

A. *Total*, *i.e.*, almost the whole of the greater curvature with attached gastro-ic omentum passes forwards and upwards to lie between the lowered lesser rvature and the diaphragm. The torsion may be to 180° as described above d the true posterior surface of the organ present anteriorly often covered by e meso-colon, as the colon is commonly dislocated with the stomach and lies der the diaphragm. Total volvulus occasions occlusion of both the cardiac d pyloric orifices. Occasionally the torsion is posterior, *i.e.*, the greater rvature passes backwards and upwards behind the lesser curvature. Total lvulus is acute and usually primary.

B. *Partial Volvulus of Stomach.*—Frequently secondary to inflammatory ions to neoplasms or to diaphragmatic hernia. The trouble is commonly nic. Here the torsion is of the pylorus and pyloric end of the stomach. h total and partial volvulus demand operation. In partial volvulus the ble will most commonly be discovered during operation for the primary ion and the treatment will consist of detorsion and correction of the primary ion, *e.g.*, division of adhesions; cure of diaphragmatic hernia: treatment of glass stomach, etc., etc.

In total volvulus diagnosis has on several occasions been made prior to, but re frequently during operation. The story of the operation is usually as lows: Median incision from the ensiform cartilage to the umbilicus. On

opening the abdomen a large cyst presents covered by a vascular membrane, the mesocolon. It is impossible to orient the cyst because of tension, etc. Tear a hole through a non-vascular area of the membrane. Protect the abdominal cavity very thoroughly with gauze pads. Puncture the cyst as high up as possible and drain its contents through a canula. Close the puncture in the cyst by a double row of sutures; the second row being of the Lembert sort. Exploration is now easy and the cyst is found to be the stomach which is recognized by the arrangement of its arteries and the attachment of the great omentum. Usually detorsion is easy. If the patient's strength permits it is recommended to insure against recurrence by performing gastropexy, *i.e.*, by fixing the anterior surface of the stomach near the lesser curvature to the abdominal wall by a row of sutures. Lenormant ("La Press. Med.," May 11, 1912) has collected 11 cases of total volvulus with 7 recoveries and 6 cases of partial volvulus with 5 recoveries. (For information regarding gastric volvulus see Payr, "Mittheilungen d. Grenzgeb.," xx, 686; Lenormant, "La Presse Med.," May 11, 1912; Tuffier and Jeanne, "Rev. de Gyn. et Chir. Abdom.," Jan., 1912.)

Volvulus.—Open the abdomen. Find the site of obstruction. Empty the gut by incision. Gently endeavor to unravel the knotted or twisted intestine. If reduction is impossible and there is no interference with the blood-supply of the involved gut, establish an anastomosis between the gut above and below. If the blood-supply is threatened or if for other reasons the step seems proper, excise the involved gut. Where radical treatment is impossible, the operation of intestinal exclusion or segregation may be employed.

Finsterer ("Zent. für Chir.," No. 30, 1912) finds that simple detorsion has a mortality of 35 per cent. and there were 13 recurrences in 48 cases. Colopexy (of course following detorsion) gives a mortality of 20 per cent. and is no surety against recurrence. Entero-anastomosis has a mortality of 50 per cent. When gangrene is present resection is compulsory and should be done in two stages; even when the gut is not gangrenous, resection gives the best results (mortality 7.6 per cent.). If the general condition of the patient permits, the operation may be done in one sitting. (In 23 operations, 1 death.)

A curious cause of chronic obstruction and the most frequent cause of volvulus of the sigmoid colon is the so-called "retractile meso-sigmoiditis."

From some ill-defined cause the base of the meso-sigmoid becomes covered *transversely* by bands of scar tissue which contract and in severe cases may bring both segments of the sigmoid together like the barrels of a gun. This of course can cause narrowing of the lumen and obstruction with subsequent dilatation of part of the sigmoid loop and of the descending colon. Distention of the bowel and interference with the circulation are liable to lead to ulceration of the mucosa, etc. Fixation or stiffening of the sigmoid is a predisposing cause of volvulus.

Treatment.—If the bowel does not seem severely affected, divide the bands of scar tissue which contract the meson; in some cases this permits the meson to spread out to its normal condition. If the above measure fails to release the meson or if the gut is much affected it is advised to resect the involved intestine.

some cases an anastomosis might overcome the trouble. (Duval, "Arch. s-malad. de l'appar. digestif," 1907, No. 1; "Ref. Centralblatt für Chir.," 1907, No. 37.)

Bands, Etc.—Bands or strands of omentum, etc., causing obstruction are to be doubly ligated and divided, or rather excised. When dividing such bands, examine them carefully lest they should consist of diverticula with mucous lining, in which case they must be treated in the same fashion as the stump left by the excision of the vermiform appendix.

Sometimes bands pressing on the gut cause gangrene, the gangrene involving all or nearly all of the circumference of the gut while it involves little of the long axis of the gut. This segment of gut may be excised though it is probably much better, especially in the feeble, to invaginate the gangrenous gut by a row of Lembert sutures. The invaginated tissue is dead and soon sloughs off leaving the lumen of the gut patent (Fig. 572). This operation was devised by J. E. Summers and carried out successfully by him in three cases; two of these were strangulated herniæ and one was of gun-shot wound of the intestines.

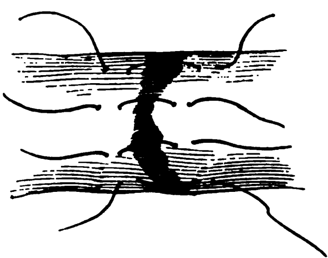


FIG. 572.—Summer's method.

Adhesions.—The best treatment for obstruction from adhesions, to use an Irishism, is *not* to have the adhesions. The principal *prophylactic* means to this end is, when operating, to leave as few raw surfaces as possible within the belly. Wherever possible, raw surfaces, pedicles, etc., should be covered with peritoneum, even if some plastic work be required for this purpose. Where it is impossible to cover the surfaces with neighboring peritoneum, portions of omentum may be ligated and cut off, and these fragments plastered over the raw surface. Cargile's ingenious membrane is useful for the same purpose and is probably better than the omental graft. The *active* treatment of adhesions is to break them up, either by sharp or blunt dissection, and cover the raw surface as above described. When a gut is adherent to the parietal peritoneum or to an organ of lesser importance, and in freeing it injury to one or the other is probable, be careful to sacrifice the less rather than the more important organ. If it is impossible safely to separate the adhesion causing obstruction restore the fæcal circulation by establishing an anastomosis between the gut above and below the obstruction.

Foreign Bodies.—For the treatment of obstruction due to this cause see remarks on enterotomy (page 405).

Enterostomy.—The term "enterostomy" signifies an operation to establish a communication between any portion of the intestine and the exterior of the body, whether this opening be used for the introduction of food, etc., or for the evacuation of intestinal contents.

Jejunostomy.—This operation is of value in providing absolute rest to the stomach in cases of hemorrhage when other more direct methods of treatment are unavailable. Mayo Robson ("Brit. Med. Journ.," Jan. 6, 1912) thinks

jejunostomy of great value in jejunal ulcer following gastro-enterostomy when the patient is too feeble to permit of more extensive work. He finds it also valuable in "ulcer near the cardiac end of the stomach, or along the lesser curvature as also in some ulcers of the duodenum that have failed to yield to medical treatment" if there is no pyloric stenosis. v. Milkulicz considers jejunostomy "inhuman" when used to prolong life in cases of stenosis from gastric cancer.

The Operation.—Expose and examine the stomach exactly as in gastro-enterostomy in order to prove that some other and better operation than jejunostomy may not be possible. Bring a loop of jejunum, 6 or 8 inches below the duodenojejunal angle, into the abdominal wound and suture it to the fascia and skin. Close the excess of parietal wound. Either at the same sitting or a few days later make an opening into the exposed portion of jejunum of a size sufficient for the introduction of a soft-rubber catheter. Feed with predigested ood through the catheter.

An imitation of the Stamm-Kader operation may be used or, better still, of the Witzel gastrostomy. The great objection to jejunostomy is the constant and inevitable escape of bile and pancreatic juice through the fistula. To obviate this evil Maydl, after exposing the jejunum, divides it transversely about 8 inches below its origin; the open end of the upper segment he implants into the side of the lower, about 8 inches below the line of section, and then unites the open end of the lower segment to the skin. The principle is identical with that of Roux's gastro-enterostomy, and is most excellent; the only criticism on it is that patients requiring jejunostomy are usually in a very feeble condition and cannot withstand much operative interference.

Instead of a rather complicated Maydl operation, one may make an entero-enterostomy between the afferent and efferent segments, and, if desired, obliterate the lumen of the afferent segment, by means of a purse-string suture, between the site of the anastomosis and the fistula.

Colostomy (often called colotomy).—The most common indication calling for colostomy is obstruction, and then, according to the method of operating adopted, either a part or the whole of the intestinal contents escape through the artificial anus. When operation is indicated for the application of remedies (douches, etc.) to the inside of the colon some method is adopted by which escape of fæces is prevented (see cæcostomy) or appendicostomy is substituted for colostomy.

Lumbar Colostomy.—The operation is practically the same whether it is done on the right or the left side. Right lumbar colostomy is very valuable in colonic obstruction when the cause of the obstruction can be subsequently removed. For permanent artificial anus the left inguinal region is preferable. The following description applies to the left lumbar colostomy:

Step 1.—Place the patient on his right side with a firm rounded pillow under his right loin. Find a point on the crest of the ilium midway between its anterior and posterior superior spines. From a spot a little in front of and 1 inch above, the mid-point of the ilium, make an incision, 3 to 4 inches in length along an imaginary line leading to the junction of the spine and the last rib

(Bryant's incision). Divide the skin and subjacent muscles along the whole length of the superficial incision. Attend to hemostasis. Expose and divide the transversalis fascia, exposing the subperitoneal fat.

Step 2.—With blunt dissection penetrate the exposed fat in which the colon is to be found. The colon may always be discovered in front of the lower border of the kidney. Be careful not to open the peritoneum; but if this accident occurs, make use of the opening to aid in locating the colon; which being done, close the peritoneum either by suture or ligature.

Step 3.—*Method A.*—Having found the colon, pull it up into the wound and pass a stout suture through the skin (not the muscles) on one side of the wound, through the colon, and out through the skin on the other side. Clean the lumbar wound and close its deep parts with a few catgut sutures. Close the superficial lumbar wound with silkworm-gut, except opposite the prolapsed gut. Make a small opening into the gut over the suture which traverses its lumen. Pick up and pull out the centre of the suture traversing the gut and divide it. Tie the two halves of the suture and thus fix the sides of the intestinal opening to the skin. Introduce any more sutures which may be necessary.

Method B.—Operate as above, but instead of merely incision of the colon, completely divide it, close its lower segment completely, and suture the whole circumference of the upper segment to the skin (Madelung).

Method C.—Bring a knuckle of gut outside the wound, protect it with dressings, and open it after the lapse of three or four days. Any lumbar wound which is in excess of what is required for the passage of the gut must be closed by sutures. It is unnecessary to fix the gut in the wound by means of sutures.

Inguinal Colostomy.—When the operation is done on the left side, it may be named sigmoidostomy, but the operation is practically the same whether it be a right inguinal colostomy or a sigmoidostomy. A sigmoidostomy will be here described.

Step 1.—Draw an imaginary line from the anterior superior spine to the umbilicus; make an incision 2½ inches long, crossing this line at right angles and distant 1½ inches from the anterior superior spine. One-half the cut is above the line and one-half below (Harrison Cripps' incision).

Step 2.—Find the colon, recognizable from its longitudinal muscular bands and appendices epiploicæ. Pull it into the wound.

Step 3.—*Method A.*—Pass two silk sutures, two inches apart, through the free margin of the gut. These are for traction purposes and serve as guides. Suture the loop of gut to the edges of the inguinal wound. If the case is urgent, open the gut at once; if there is no urgency, apply dressings and incise the colon after the lapse of three or four days. In this operation there is no attempt made to compel the complete evacuation of the bowel through the artificial opening; much of the colonic contents are at liberty to pass down into the lower gut.

Method B.—Gently pull out of the wound as much of the upper segment of gut as will come down and push it back again through the lower angle of

the wound. This is done so that the intestinal opening may be made in a part of the gut well supported by mesentery, and thus prolapse be avoided. Introduce traction sutures as in Method A. Suture the protruded loop of gut to the abdominal wound. The sutures should be so placed that at least two-thirds of the circumference of the gut is external to the line of stitches. Open the gut either immediately or after the lapse of 3 or 4 days. The object of

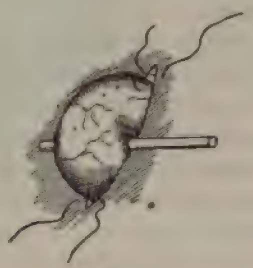


FIG. 573.

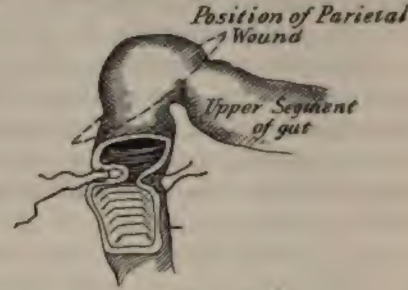


FIG. 574.

FIGS. 573 AND 574.—Colostomy.

making so much gut protrude is to form a spur or obstacle to the passage of fæces into the lower segment of bowel. Paul thinks a spur is usually disadvantageous and so does not permit so much of the circumference of the gut to be external to the line of stitches.

Method C is almost the same as Method B. After pulling the gut downwards so as to obtain mesenteric support, pass a glass rod under the selected loop of gut, through its mesentery. The ends of the glass rod rest on each side of the skin-wound and support the loop of gut (Fig. 573). Close the belly-wound, leaving sufficient room for the passage of the loop of gut held in place by the glass rod. Apply dressings. Remove the glass rod and open the gut after union has taken place between the gut and the parietes. In opening the gut it is best to divide it transversely and slowly with the thermocautery. If there is an excess of gut protruding, it may well be excised with the cautery. No anesthetic is necessary as the intestine is not sensitive. This is a convenient and good method. A variant in the method is (1) after opening the abdomen suture the parietal peritoneum to the skin. (2) After the glass rod is in position suture the intestinal serosa to the parietal peritoneum or to the skin.

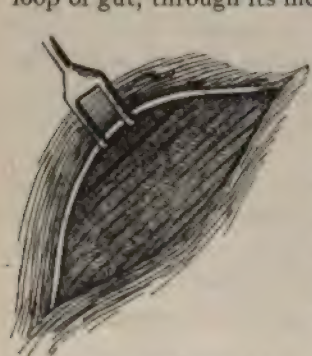


FIG. 575.—Cripp's incision.

Method D.—Find the colon, pull it downwards so as to provide mesenteric support. Apply clamps to the gut and divide it. Close the lumen of the lower segment by inverting its cut edges and suturing. Suture the whole circumference of the upper segment to the skin. Close the excess of skin-wound after removing the clamps.

Methods E and F.—Instead of dividing the gut, and before opening it, Mosetig-Moorhof creates a valvular obstruction in the lower segment by inserting a few Lembert sutures (Fig. 574). The same object may be attained by encircling the gut with a loop of wire or with a purse-string suture of silk.

Method G (Wyeth's Operation).—All the methods already described have been devised in the belief that prolapse of the afferent segment of the gut is the principal trouble after colostomy. This belief is not correct. The chief trouble is that there is no rectum to act as a natural reservoir for fæces. The following operation provides such a reservoir and also prevents any great prolapse of mucous membrane.

Step 1.—Make an incision through the skin alone, parallel to and 1¼ inches below the Harrison Cripps' line of incision (page 447). Pull the superior edges of the skin incision upwards so as to expose the deep sutures of the belly-wall at the Harrison Cripps' line (Fig. 575). Divide the deep structures along this line and so open the belly.

Step 2.—Pull the sigmoid flexure out of the wound; push all excess of sigmoid *up* into the belly so that as little gut is left below the eviscerated loop as possible, *i.e.*, the portion of gut to be united to the belly-wall is chosen as low down the intestine as is possible. By this means a fæcal reservoir is provided.

Step 3.—Treat the eviscerated segment of gut in much the same manner as is recommended in the preceding methods. If it is desired to open the gut at once, it is wise to fasten a tube into it by means of a purse-string suture, much in the manner described in Paul's colectomy. Some surgeons strongly advise against suturing the parietal peritoneum to the skin, as when this is done there is not such good union between the gut and the parietes. Excise all the appendices epiploicæ from the eviscerated segment of gut, as otherwise they will surely slough off, slowly and with much stench. In applying dressings always separate the dressings from the exposed gut by a layer of rubber tissue or perforated oiled silk. This simple device saves much trouble from the sticking of dressings to the parts and is very conducive to cleanliness and avoidance of stench. In time the opening in the skin and that through the deeper structures come to lie close to each other; not so close, however, as to do away with the valve action desired.

Method H.—Mixter's anterior colostomy.

Step 1.—Make the incision shown in Fig. 576. The outer portion of the incision must be a short distance inside of the outer edge of the rectus muscle. The incision divides the skin, subcutaneous tissue and the rectus fascia. Reflect outwards the quadrilateral flap outlined.

Step 2.—Split the rectus muscle near its outer margin. Open the abdomen.

Step 3.—Deliver a loop of the sigmoid as in Step 2, Method G.

Step 4.—Split the meso-sigmoid for about 2 inches at a right angle to the long axis of the bowel. Suture the two edges of the middle portion of the separated rectus muscle together through the opening in the meso-sigmoid (Fig. 577).

Step 5.—Push the reflected flap of skin and rectus fascia through the opening in the meso-sigmoid and suture it in its original position (Fig. 578).

After four or five days the exposed coil of sigmoid may be resected, when bleeding from the cut ends of the intestine may be controlled by a continuous suture of catgut. The proximal and distal openings are wide apart and the

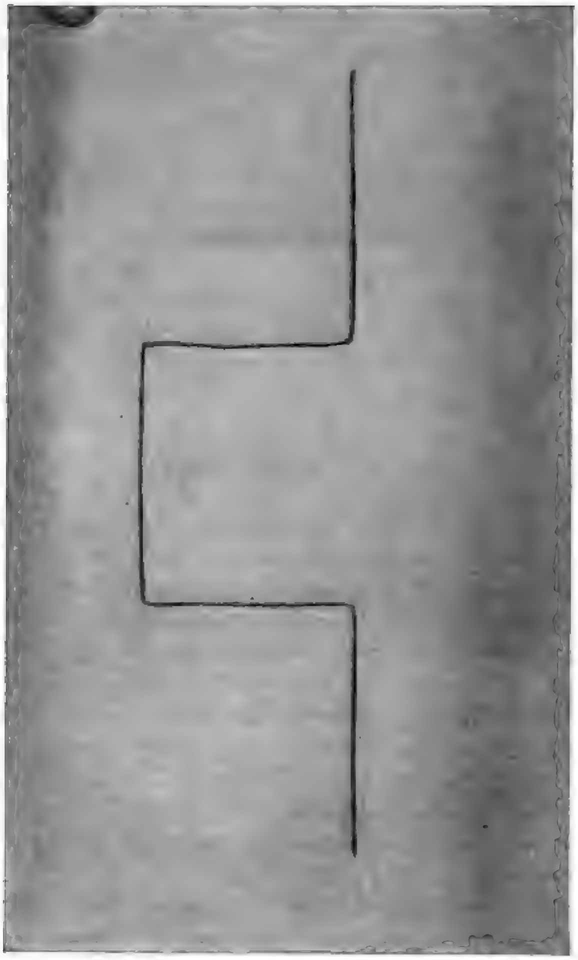


FIG. 576.—Mixter's anterior colostomy. (*Gould.*)
Line of incision.

rectus acts as a sphincter. Through the distal opening it is easy to flush the rectum (Fig. 579). If obstruction is acute one may open the bowel in Step 5 and insert a glass tube (Paul's tube; Mixter's tube).

Method I.—Littlewood's Colostomy.—Make a vertical incision from the tip of the twelfth rib on the left side downwards to a point behind the anterior superior iliac spine. Expose the descending colon and open it as far back as

possible on its outer side so as to leave no chance for the small intestine to find a niche in which it may become strangulated. This operation has a number of important advantages. The new anus is far from hairs and hence is comparatively sanitary. Almost any belt around the waist will suffice to hold an occlusive pad in position.

FIG. 577.—Anterior colostomy. (*Gould.*)
Sigmoid withdrawn, mesentery pulled taut and incised. Rectus muscle sewed together between afferent and efferent coils.

Method J.—McGavin's Transversostomy (Clin. Soc. Trans., 1906; Brit. Med. Journ., May 10, 1913).—Make a vertical incision 2 inches to the left of the linea alba and with its upper end 2 inches below the costal margin. Split the rectus. Open the abdomen. Pull out the transverse colon so as to form a good "spur" and complete the operation as in Method C. There is much to be said in favor of McGavin's method. The patient can subsequently care for

himself easily. An occlusive pad is efficient and easily worn. The rectus muscle forms a fairly good sphincter. The colonic contents are not so foul as are those of the sigmoid and while not so solid are yet sufficiently so. The new anus is remote from the disease.

Method K.—Cæcostomy.—The author has found this operation of value as a substitute for appendicostomy. In autopsies on those dying from corrosive

FIG. 578.—Anterior colostomy. (*Gould.*)
Flap fastened into original position under arch of sigmoid, with two layers of sutures. Mixter tube in place.

sublimate poisoning, C. C. Conover found that the mucosa of the pyloric end of the stomach is affected being black in color, but that the muscular and peritoneal tunics are not seriously involved, that the small intestine escapes damage, that the cæcum and colon are the sites of severe ulceration. The colonic ulceration begins within twenty-four hours of the swallowing of the poison and death occurs usually within thirty-six hours. Adami (Brit. Med. Journ., Jan. 24,

1914) writes, "we have clear evidence that the mucosa of the colon is a region of active excretion; we know, for example, that antimony and mercury are discharged from the blood by this path." Conover suggested that early cæcostomy with lavage of the colon every three hours (better continuous lavage) kept up for from two to four days might prevent the colonic ulceration. Conover's treatment has been carried out in a few cases at the Kansas City General Hospital with uniformly good results.

FIG. 579.—Anterior colostomy. (*Gould.*)
Sigmoid resected ¼ to ½ inch above skin level. Circumference of cut edges sewed with catgut.

L. L. McArthur finds that irrigation of the colon through an appendicostomy or cæcostomy opening is of actual curative value in tuberculous ulceration in any portion of the gut distal to the caput coli. This includes of course the sigmoid and rectum.

Step 1.—Expose the cæcum by means of the McArthur-McBurney muscle-splitting method.

Step 2.—Choose a part of the cæcum which can be easily approximated to the abdominal wound and introduce a purse-string suture of catgut (Fig. 580) penetrating the whole thickness of the cæcal wall.

Step 3.—Incise the gut inside the circle formed by the purse-string suture. Through this incision pass the bulb of a Jacob's self-retaining catheter into the lumen of the gut. Tie the purse-string snugly around the shaft of the catheter but not tightly enough to obstruct its lumen. No fæcal matter can now escape alongside the catheter and no bleeding from the intestinal wound is possible. Cleanse the field of operation.

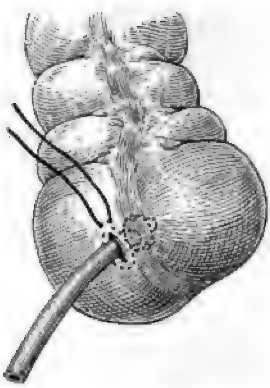


FIG. 580.—Cæcostomy.

Step 4.—At a distance of 1/4 to 1/2 inch from the catheter introduce a purse-string suture of hemp or silk and tie this line of suture snugly (but not too tightly) around the shaft of the catheter. Leave the ends of the suture long. Instead of the above method a modification of the Witzel plan for gastrostomy may be used.

Step 5.—Pull the free end of the catheter through the abdominal wound so as to bring the cæcum into apposition with the parietal peritoneum. Stitch the long ends of the purse-string suture to the parietal peritoneum. Close the abdominal wound. Before applying dressings pull the catheter in such a fashion that its bulb (inside the cæcum) will bring the cæcum into contact, with the parietal peritoneum. Before closing the abdominal wound, the cæcum, near the catheter, may if desired be united to the parietal peritoneum by one or two stitches. This is rarely necessary. Before introducing the catheter into the cæcum its free end may be clamped by a hemostat.

The catheter is left *in situ* as long as it is required for irrigation of the colon. To remove the catheter cut it flush with the skin and with a probe passed through the lumen of the remnant poke the bulb into the gut. Owing to the invagination of the cæcal wall the fistula closes promptly as soon as the catheter is removed.

Weir suggested that the appendix might be used in the formation of a fistula through which the colon could be irrigated. The operation is only feasible when the appendix has a lumen large enough to permit the passage of a small catheter and when absence of adhesions and presence of sufficiently long meso-appendix permit its being brought out through the abdominal wall without interference with its nutrition.

Step 1.—Open the abdomen through a small incision as for appendectomy.

Step 2.—Bring the appendix out through the wound without twisting or exerting undue pressure on its meson.

Step 3.—Prevent retraction of the appendix into the abdomen either by

uniting the cæcum or the appendix to the parietes by one or more sutures, or by passing a safety-pin through the meso-appendix exactly as a rubber drainage-tube is secured.

Step 4.—Close the abdominal wound being careful not to exert pressure on the appendix or its blood-supply. After adhesions have formed between the appendix and the wound cut off the protruding tip of the appendix flush with the skin and introduce a soft-rubber catheter into the cæcum as often as may be required. When it is desired to close the fistula remove the mucosa of the appendix either by the cautery or by dissection or remove the appendix itself.

If the colostomy opening is small the patient may be kept in comfort by careful regulation of the bowels and by plugging the fistula with a mushroom-shaped aluminum plug held in place by a pad and belt.

Closure of Artificial Anus or of Fæcal Fistulæ.—When colostomy has been performed as a preliminary step in excision of the rectum or for therapeutic purposes, or when the obstruction which called for it has been removed, it becomes necessary to close the artificial anus. When no "spur" preventing the onward passage of fæces is present, all that may be required is to dissect the mucous membrane free from the skin, turn inwards, stitch its edges together, and then suture the now raw edges of the abdominal wound. When a "spur" is present (*vide* Methods B and C, page 447), one may apply a clamp to the spur and leave it in position until by pressure it causes the "spur" to slough away (Fig. 581). This takes away all opposition to the onward flow of the contents, and fistula may be closed in the manner already described. Such was the manner of operating devised by Dupuytren, and until comparatively recently was the accepted method. The dangers of the method are: (*a*) peritonitis; (*b*) accidental inclusion of a knuckle of intestine within the clamps. Other and more precise methods are now in use.

The Operation.—Prepare the patient by evacuating the bowels throughly forty-eight hours before operation. Immediately prior to the operation give an opiate to keep the bowels inactive for a short time.

Step 1.—Cleanse the skin around the fistula and scrub the fistula itself. Cauterize the fistulous opening with the thermocautery, liquid carbolic acid, or pure formalin. Close the opening tightly with a purse-string suture after packing it with a small plug of gauze. The suture is inserted in the skin, and when tied prevents soiling of the neighborhood by intestinal contents (Fig. 582, L). Once more cleanse the field of operation.

Step 2.—Make an incision through the parietes at a point above, below, or to the side of the fistula, and open the abdominal cavity. In choosing where to make this incision endeavor to find a spot close to the fistula where the tissues are not much altered, and where the viscera are not adherent to the parietal peritoneum.

Step 3.—Introduce the finger into the belly and explore the relations of the adherent gut to the abdominal wall. Guided by the exploring finger, enlarge the incision, making it run around one side of the fistulous opening (Fig. 582, I, N).

Step 4.—Retract the flap formed by the incision I, N. This exposes the gut and its connection with the inner surface of the parietes at the fistula (Fig. 583, X, Y).

Step 5.—*Method A.*—If the connection between the gut and the parietes is small in extent, empty the gut of its contents by stripping it with the fingers, and keep it empty by suitable clamps. Protect the abdomen with pads; divide the union between the gut and the parietes; close the hole in the gut by a double row of sutures, as is done in enterotomy.

Method B.—If the connection between the gut and the parietes when separated leaves such a defect that simple closure would lead to stenosis, either

FIG. 581.

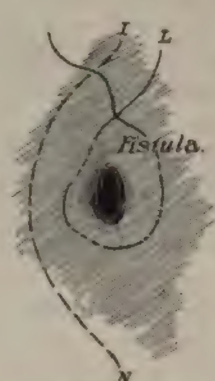


FIG. 582.

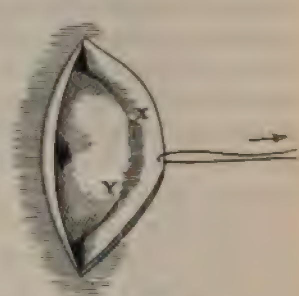


FIG. 583.

FIGS. 581, 582 AND 583.—Closure of fæcal fistulæ. (*Esmarch and Kowalzig.*)

counteract the effect of the stenosis by anastomosing the afferent and efferent loops or excise the injured portion of gut and restore the continuity of the gut as is done after any enterectomy.

Method C.—If the union between the gut and the parietes is very extensive, and if for any reason the above methods are inapplicable,—*e.g.*, presence of extensive and dense adhesions, or the inaccessible location of the fistula,—then the operation of bilateral exclusion may be performed. In this case the next step in the operation, after the exclusion has been accomplished, would be closure of the abdominal wound and removal of the purse-string suture around the fistula, as that opening is required for the drainage of the excluded segment of gut. A cure of the fistula may be expected, but only after a lapse of much time. The method by "exclusion" or "segregation" is not a method of choice, but of necessity, and when done, removal of the mucous membrane from the segregated gut, if possible, is an advantage.

Step 6.—The continuity of the gut having been established, excise the fistula and as much of the surrounding sclerosed tissue as may be necessary to secure healthy structures for suturing. As a rule, in severe cases, the whole of the flap outlined by the cut I, N, Fig. 582, will require removal, and sometimes even more tissue must be sacrificed.

Step 7.—Close the abdominal wound, preferably without drainage.

The operation thus described will generally be found satisfactory. Its extent is rendered necessary from the fact that the fistula is usually surrounded by much scar tissue which, unless thoroughly extirpated, will almost surely lead to the formation of a post-operative hernia. In a few cases where there is not much deposit of scar tissue and where the fistulous track is short and leads directly into the gut, a much simpler procedure may be adopted.

Step 1.—After thorough cleansing of the fistula and the whole neighboring skin make an incision around the fistula at the junction of the skin and mucous membrane. Through this incision dissect the fistulous track free from its surroundings until the gut is reached.

Step 2.—The fistulous track is now attached to the gut alone, and hangs on it very much as the vermiform appendix hangs on the cæcum after the appendicular mesentery is divided. Remove the fistulous track in the same manner as the appendix is excised and treat the resulting stump similarly.

Step 3.—Close the abdominal wound with or without drainage.

Instead of operating as above, one may open the belly in the middle line, find the loops of gut leading to and from the artificial anus, and make an anastomosis between them, subsequently closing the fistula. In this method it is much easier to keep the peritoneum from being soiled than in the preceding.

When it becomes desirable to close the artificial anus made by dividing completely the gut, closing and dropping its lower segment into the belly, and suturing the upper segment to the abdominal wound, the operation to be chosen is one done on the following lines:

Empty the bowels by means of purgatives or enemata. Administer an opiate shortly before operating to lock up the bowels. Pack the artificial anus with gauze to prevent escape of contents during the operation. Open the belly, preferably in the middle line. Find the lower segment of gut. Find the loop of gut which is attached to the skin and forms the artificial anus. Make an anastomosis between the lower segment of gut and loop of gut above that which forms the artificial anus. Close or excise the artificial anus either at the same sitting or subsequently. Close the abdominal wound.

CHAPTER XXXV

THE VERMIFORM APPENDIX AND PERITONEUM

OPERATIVE TREATMENT OF APPENDICITIS

Appendicectomy.—As different methods have been devised for carrying out almost every step of appendicectomy, it may be convenient to describe shortly a number of these methods under the headings Step 1, 2, etc.

Step 1.—Opening the Abdomen.—(A) *McBurney Method.**—This method is especially suitable where no drainage of the abdominal cavity is required; drainage, however, may be effected either through the wound itself or better, through a special stab wound made in a convenient position. Under proper conditions the method is ideal. The principle involved is avoidance of transverse division of muscles or tendinous fibres, so that when healing has taken place there is no post-operative weakness of the belly-wall.

The Operation.—Make a three inch incision through the skin and subcutaneous fat. The cut begins at a point one inch above a line joining the anterior superior spine of the ilium and the umbilicus, and crosses it at a point one and one-half inches from the anterior superior spine. The incision runs downwards and inwards in the same direction as the fibres of the external oblique muscle and aponeurosis. Separate the fibres of the external oblique for the whole length of the wound without cutting any of them transversely. This can be done with the handle of a knife and the finger. With retractors pull apart the edges of the wound in the external oblique and expose the underlying internal oblique and transversalis muscles, whose fibers run approximately at right angles to the superficial wound. With blunt dissection traverse these muscles so as to make a wound in them, parallel to their fibres and at right angles to wound in the external oblique. Blunt retractors are introduced to keep this wound open and expose the fascia transversalis, which is divided in the same direction as the wound of the internal oblique. After this the peritoneum is picked up in forceps and opened. Special care has to be taken in opening the peritoneum, as it is frequently found adherent to the cæcum or other abdominal contents. The same rules apply to the opening of the peritoneum as to the opening of the sac in cases of hernia.

Closure of the Wound.—Separate suture of the peritoneum and of the transversalis fascia. The wound in the internal oblique and transversalis muscles requires but one or two points of suture. Suture of the external oblique.

* L. L. McArthur undoubtedly devised and carried out this muscle-splitting operation in about thirty cases before McBurney did so. Unfortunately he failed to publish his method promptly enough. Needless to say McBurney was not acquainted with the above fact when he described his operation.

.aterial varies according to the fancy of the ·atgut.

·l extends far up towards the liver its distal end ·ond incision entirely similar to the first but at a ıgh both incisions a difficult operation may be :ter danger of post-operative hernia incurred.

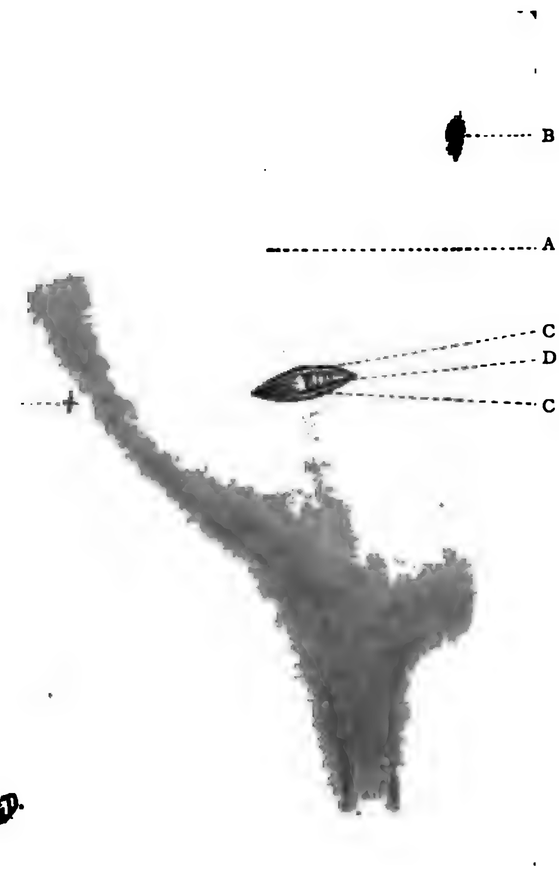


FIG. 584.—Davis' incision.
;ıne. A. Ext. edge rectus. B. Umbilicus. C. Fascia of external oblique. D. Exposed rectus.

,btain more room Weir, after splitting the fascia of the external :tes it from the anterior surface of the rectus, splits the internal ·ansversalis like McBurney, but continues the split or incision ırough the anterior layer of the sheath of the rectus, retracts the owards the middle line, and lastly divides the posterior layer eath along with the peritoneum. Closure of this wound presents ılties. Not 'ividing the posterior layer of rectus sheath

the epigastric vessels ought to be found and ligated before division. In Weir's operation retraction of the rectus inwards may possibly injure or tear the nerves; therefore the author modifies the method by dividing the rectus as far as necessary after suturing, in two lines, the aponeurosis covering it anteriorly to the muscle. He also often reverses the steps of the operation, beginning by transverse section of the rectus in the interspinous line and afterwards, if necessary, enlarging the wound outwards and upwards in the gridiron fashion.

(B) *G. G. Davis Incision* ("Annals of Surg.," Jan., 1906).—Locate the outer border of the right rectus at the level of the anterior superior spine. Make a transverse incision through the skin 1½ inches long, having the edge of the rectus as its mid-point (Fig. 584). Divide the aponeurosis of the external oblique obliquely to the direction of its fibres, but directly in the line of the skin wound. Split, do not cut, the internal oblique and transversalis muscles. Open the peritoneum. Carry the cut inwards through the *anterior* layer of the sheath of the rectus. Retract the rectus towards the middle line. Divide the *posterior* layer of rectus sheath along with the peritoneum.

If more room is required, prolong the incision outward towards or even to the anterior superior spine and, if requisite, inwards through the rectus sheath to within an inch of the median line.

(C) *Rectus Incision.*—Locate the outer border of the right rectus. Beginning at a point one inch above a line joining the anterior superior spine to the umbilicus, make an incision downwards, about one-half inch internal and parallel to the edge of the rectus. The incision, 2½ inches in length, may be increased if necessary. Expose and split the anterior layer of rectus sheath. Split the rectus muscle *or* retract the muscle (Kammerer; Lennander; Battle; Jaboulay) inwards to expose the posterior layer of sheath. Divide the posterior layer of rectus sheath and open the abdomen. This incision is good in almost all cases of appendicitis except when there is a large abscess present and located more or less externally. The wound may be closed in layers or by through-and-through sutures.

(D) *Incision through the linea semilunaris* requires no special description.

(E) *Oblique Incision.*—Locate the outer border of the right rectus muscle. Beginning at a point one inch above an imaginary line joining the anterior superior iliac spine to the umbilicus, make an incision parallel to, and about ¾ of an inch external to, the edge of the right rectus muscle. This cut runs downwards and slightly inwards for about 3 inches. The fibres of the external oblique and its aponeurosis can be split longitudinally by blunt dissection; the deeper structures are divided in the direction of the wound. The usual care must be exercised in opening the peritoneum. A good practical rule to adopt in operating is as follows: Make a 3-inch incision as above described down to the external oblique; make a small opening through the remainder of the belly-wall; introduce the forefinger to explore; if it is easy to complete the removal of the appendix through the small opening, do so; if not, enlarge the wound to the necessary extent. The size of the skin-wound is of little importance—the smaller the wound of the deep structures (of the *essential*

lly-wall), the less danger will there be of hernia. The wound must be large ough to permit of *easy* access to the field of work. After completing the ppendicectomy, the wound may be closed in layers or by one layer of sutures versing the whole thickness of the belly-wall.

(F) *Inferior or External Incision.*—From a point about two finger-breadths ternal to the right anterior superior iliac spine and one inch above the line ining the umbilicus and the ilica spinous process make a 3-inch incision ossing the above line at right angles. Having made the skin-incision, follow the rules laid down for Method C.

(G) Through one of the previous incisions an abscess has been found but not opened. This abscess lies posteriorly and ought to be evacuated through the loin, *i.e.*, extraperitoneally. Guided by the finger in the belly make an incision directly over or, better, to the outer side of the abscess. After incising the parietes, but before opening into the abscess, close the exploratory wound, penetrate the abscess cavity, cleanse and drain it. In the same manner when large abscesses have been opened through the primary incision, one or more counter openings may be made to secure efficient drainage.

(H) In exceptional cases the primary opening may be made wherever the abscess tumor idicates, *e.g.*, the writer has opened an appendicial abscess in the *left* iliac region.

Step 2.—Search for and isolation of the appendix.

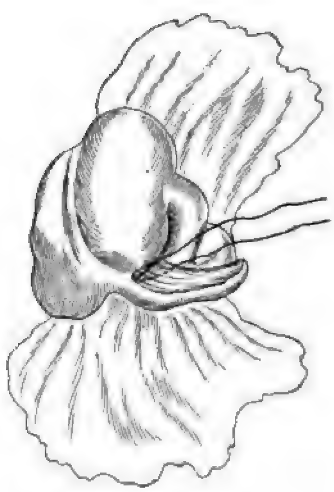


Fig. 585.—Ligation mesoappendix.

(A) Digital exploration. The forefinger or, if necessary, two fingers are introduced into the belly and the ascending colon is recognized. The finger follows the colon to the end of the cæcum and is systematically moved about its blind extremity, separating *gently* any adhesions which may be present and which interfere with the search. If the adhesions are firm or resist the gentle manipulations advised, then the next method to be described must be employed. The appendix may lie in any position near the end of the cæcum and may be either curled up on itself or extended. Having found the appendix, gently separate it from its surroundings and deliver it through the wound. The mesentery of the appendix is transfixed close to the appendix and colon, a ligature drawn through, the mesentery ligated and divided (Fig. 585). If the mesentery is voluminous, it may be necessary to apply two interlocked ligatures. The digital exploration may be accomplished as follows: Pass the finger along the outer surface of the colon over the brim of the pelvis into the true pelvis. Feel for the pulsating iliac artery. Slip the finger upwards on the surface of the artery and bring the finger out of the true pelvis. If the finger is slightly hooked while being brought out of the pelvis it will bring up a

loop of small intestine. This loop of small intestine is the ileum close to the cæcum and is within an inch of the base of the vermiform appendix. The treatment of the appendix itself belongs to Step 3.

(B) If it proves difficult to find and isolate the appendix by Method A, the wound must be enlarged so that the eye may aid in the exploration. First recognize the ascending colon. This is easily done by noting its longitudinal muscular bands. Follow the anterior muscular band downwards; it leads directly to the base of the appendix.* The isolation of the appendix may be accomplished in two ways: If one readily finds its distal end, one begins isolating there and works towards the base. Any rigid adhesions should be ligated with fine silk or catgut and divided. If adhesions to intestines are firm and short, one must remember a cardinal rule in abdominal surgery, viz., sacrifice part of what is being removed if non-malignant, rather than injure the viscus. If necessary, a thin layer of the appendicular wall (never containing mucosa) may be left attached to a gut so as to avoid laceration of the gut-wall. If it is difficult to find the distal extremity of the appendix, isolation may be begun at its base. When the base of the appendix is isolated, dissection may be much facilitated by passing a ligature through the mesenteriolum (this ligature may be later used to ligate the organ or its meson). Traction on the ligature brings the base of the appendix into the wound (Lilienthal, Am. J. Surg., Ap. 1908). If there are many adhesions, after traction and dissection have exposed more of the appendix, another traction ligature may be passed through the mesenteriolum further along. This little "dodge" is of great aid and lessens handling of neighboring viscera. It is occasionally necessary to divide the appendix at its base before it can be removed. If this is necessary, one applies a clamp to or ties a ligature around the organ *distal* to the point of section and cauterizes the cut surface. This prevents contamination by the appendix while being isolated and while its cæcal extremity or stump is being treated. Under such circumstances Step 3 is proceeded with before the appendix itself is removed.

Not infrequently the longitudinal muscular band of the colon passes over the end of the cæcum and disappears at the reflection of the cæcal peritoneum to the parietes, and no appendix is visible. In such a case the appendix is retroperitoneal and retrocæcal. It may be discovered as follows: Pull the cæcum towards the middle line. Incise the parietal peritoneum immediately external and parallel to the cæcum. Introduce the finger into the newly made peritoneal wound and insinuate it behind the cæcum so as to mobilize that gut, raising it from its bed. This exposes the appendix which must be shelled out of its

* Kölliker remarks that if the appendix is much adherent it drags upon the longitudinal band and as a consequence if the appendix is retrocæcal the drag makes the band curve with its convexity towards the middle line; if the appendix is median or if it lies in the pelvis the band is curved with its convexity external. Occasionally anatomic anomalies puzzle the operator. They must be borne in mind. When the cæcum cannot be found in the right iliac fossa, pick up the omentum and use it as a guide to the transverse colon; this little "dodge" has been useful to the author. Transposition of viscera is a condition which must be remembered.

lair. It has no meson in this situation. Attend to the stump as in Step 3, Method A.

Remarks.—For some years it was the ambition of many surgeons to remove the appendix through an extremely small incision, but recognition of the fact that many other conditions may symptomatically resemble appendicitis calls for thorough abdominal exploration through a reasonably large cut. Healthy appendices have been on innumerable occasions called "clubbed" and accused of crimes of which they were entirely innocent. It is true that their removal often *accidentally* relieved the conditions causing the symptoms, but often failure resulted when larger exposure would have demonstrated the real disturber of the abdominal peace.

Step 3.—Treatment of the stump.

Method A.—Tie a ligature tightly around the appendix close to the cæcum. Before ligating it is best to crush the base of the appendix with a strong clamp and then to place the ligature in the groove left by the clamp. Cut away the appendix about one-fourth of an inch beyond the ligature. Thoroughly cauterize the lumen of the stump with liquid carbolic acid. Wipe away the carbolic acid with alcohol. This method is simple and gives excellent results. The main objection to the above is that the ligature may possibly be applied beyond a stricture of the appendix, and so there may be recurrence of the disease in the stump.

Method B avoids the disadvantage pertaining to the preceding method (McBurney). The appendix is divided one-fourth inch from the colon, the edges of the stump are seized with forceps, a probe is passed through its lumen into the colon, its mucous membrane is destroyed by the application either of liquid carbolic acid or the fine point of a cautery. The carbolic acid may be applied by means of a grooved director or by a little cotton tightly wound on a fine probe. Only after the mucous membrane is destroyed does one apply a ligature around the stump close to the colon. This is a thoroughly reliable and simple method. To eliminate the raw surfaces left by this method George Gray sutures the stump of the mesoappendix to that of the appendix itself (Fig. 586).

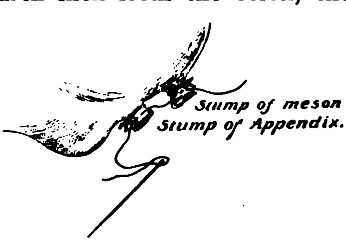


FIG. 586.—Gray's treatment of stump.

Method C.—At a point about one-fourth of an inch from the colon a circular incision is made through the serous coat of the appendix, leaving the muscular and mucous coats intact. The serous coat is separated from the muscular up to the colon. Close to the colon a ligature is tied around the tube, composed of muscularis and mucosa, and the appendix removed. The serous cuff is brought forwards over the stump and there sutured (Figs. 587, 588, 589). The method is safe, but cumbrous and unnecessary.

Method D.—Cut away the appendix flush with the colon and treat the defect as a perforation of the gut—*i.e.*, sew up the hole that is left in the colon

by a row of through-and-through sutures covered by a series of continuous Lembert sutures.

Method E.—Dawbarn applies a purse-string suture of fine silk or hemp through the serous and muscular coats of the colon around the base of the

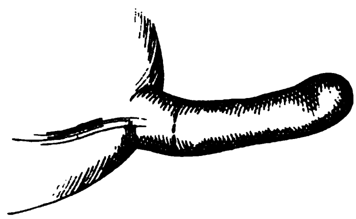


FIG. 587.

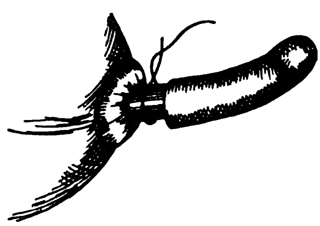


FIG. 588.

FIG. 589.

FIGS. 587, 588 AND 589.—Cuff method of treating stump.

appendix and about one-half inch distant from it (Fig. 590); cuts off the appendix; leaving a stump one-half inch in length; dilates the lumen of the stump; crushes the stump with a heavy forceps and then invaginates the stump into the colon, at the same time tightening and tying the purse-string suture.

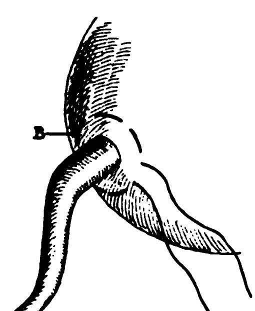


FIG. 590.—Dawbarn's method.

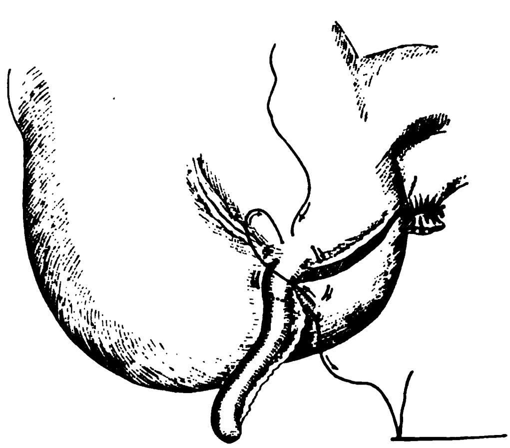


FIG. 591.—Fabrique's method.

To facilitate insertion Dawbarn suggests picking up a loop of the purse-string at B (Fig. 590); when this loop and the free ends of the thread are lifted up, inversion becomes easy.

Fig. 591 shows a better method of using the purse-string suture (Fabrique's method). The ends of the suture being on opposite sides of the wound permit better closure of the wound. Most surgeons ligate the base of the appendix before burying it as a number of cases of serious or even fatal hemorrhage into the intestine from the stump have been reported.

Method F.—This is a useful variant of Dawbarn's method. Introduce a purse-string suture as in Method E. Clamp the base of the appendix very firmly with a strong clamp. Cut away the appendix flush with the clamp and wipe the cut surface clean. Remove the clamp which has thoroughly crushed the included tissues. With a dissecting forceps grasp the stump and push it into the cæcum. Pull the purse-string suture tight and tie. The needle still remains attached to the purse-string suture; with it unite the stump of the mesoappendix of the cæcum at the point of invagination of the remnant of the appendix (Fig. 592).

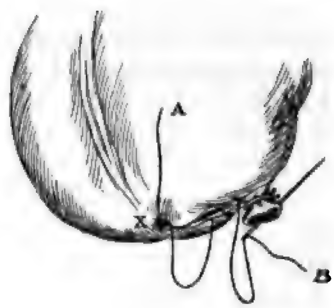


FIG. 592.

Method G.—With forceps crush the base of the appendix. Apply a fine ligature to the groove made by the crushing forceps. Remove the appendix. Bury the stump by means of Gould's mattress suture.

Step 4.—If there has been no infection outside the appendix, sponge the field of operation with moist pads and close the wound without drainage.

The operation of appendicectomy by any of the methods described in the preceding paragraphs is suitable particularly in cases of chronic or recurrent disease and in those acute cases subjected to early operation before perforation, or before periappendicular suppuration has developed. Although when the abdomen is opened there is no expectation that pus will be met, yet the peritoneal cavity must always be protected by gauze pads while the appendix is being delivered and removed. The young operator is very apt to be afraid to boldly pull the cæcum (when it is not bound down by adhesions) out of the abdomen while he operates upon the appendix. It does no harm to pull out the cæcum where this is possible, but facilitates the work and renders it safer, besides avoiding a great deal of unnecessary trauma to neighboring intestines which gives rise to much post-operative pain. The whole operation of appendicectomy ought, if possible, to be carried out external to the belly cavity.

Operation in Acute Suppurative Appendicitis without Large Abscess.—The operation is very similar to that for recurrent disease.

Step 1.—Incision C, D, E (page 460).

Step 2.—Method B (page 462) is advisable, as the aid of the eye is most valuable. During the manipulations necessary for the discovery and isolation of the appendix, the general peritoneal cavity must be protected by pads of gauze placed inside the belly-walls, around the field of operation, unless

the introduction of the pads would spread the infection which is already present. With the same object, to wit, peritoneal protection, it is wise to avoid the separation of any adhesions which might give protection and yet do not interfere with access to the appendix. While isolating the appendix and breaking down adhesions larger or smaller pockets of pus may be encountered. The contents of such must be carefully removed by sponging before further progress is attempted. The appendix, having been recognized and isolated, is found to be acutely inflamed, generally rigid, often rotten, and sometimes perforated or gangrenous. It must be removed. Its stump must be treated either by Methods A or B or by Method D (page 465). Method D is chosen if the stump is too soft and friable to hold a ligature. The appendix being out of the way, a gentle search is made for other pockets of pus; if such are found, they are treated as already described. If the appendix is retro-cæcal it may be reached as described in Step 2. Remember that retro-cæcal pus is liable to burrow upwards behind the colon and liver as well as towards the pelvis, and that it is often best drained by a tube passed through a stab wound at the outer margin of the lumbar mass of muscles. The whole field of operation is most carefully cleansed with sponges soaked in normal salt solution. The protective pads surrounding the field of work are removed and a split rubber tube or a cigarette drain is passed down to the bottom of the abscess cavity. The drain may be brought out through a stab wound and the original wound closed completely. Occasionally instead of using tubular or cigarette drains the whole infected area may be *loosely* filled with strips of plain or iodoform gauze the ends of which come out at the wound. As much of the abdominal wound as is not required to provide for drainage and future access to the field of contamination is sutured with silkworm-gut. Very abundant aseptic dressings are applied. The outer dressings will generally be found soaked with discharge within twelve hours and must then be changed.

Operation in Appendicitis with Large Localized Abscess.—Access to the abscess is usually obtained by Method F, G or H (page 461). The external incision is especially good because the pus must generally be sought to the outer side of the cæcum. When cutting through the parietes, œdema of the tissues may be noticed. If any part of the wound shows more evidence of œdema than another, one may be sure that pus is not far distant, and that the œdematous tissues will act as a guide to it. When the abscess is reached it must be opened with great care. For this purpose blunt dissection or scratching with a director is safe. The danger of opening some adherent intestine must not be forgotten. A small opening having been made into the abscess, it is enlarged by blunt force. Enlarging the opening into the abscess by means of cutting with scissors or knife is improper if it can be avoided. Many careful surgeons end the operation at this stage, contenting themselves with the introduction of a drainage-tube and perhaps some gauze packing. They apply generous dressings which are soon soaked with discharge and must be changed. The practice is safe. Other surgeons explore the abscess cavity with the finger so as to remove any fæcal concretions or find the appendix.

Often the appendix has sloughed and lies free in the pus. *Great care must be taken to avoid breaking down any protecting adhesions*, otherwise the general peritoneum may become infected. If the appendix is found attached to the cæcum and can be isolated without too great danger, it should be removed and its stump treated as already described. If it cannot be found without prolonged search, or if its isolation would endanger the integrity of the wall of adhesions protecting the peritoneal cavity, most surgeons let it alone. A few operators insist that the appendix should always be removed, but to the writer this appears an eminently unsafe doctrine. The abscess cavity is gently but thoroughly wiped with gauze moistened in warm salt solution, and loosely packed with iodoform gauze, which may surround a rubber drainage-tube. Frequently a sponge stick may be passed from the abscess into the true pelvis, where another pocket of pus may be found. Remember that infection may pass up the ascending colon and give rise to subhepatic, subphrenic, or even pleural suppuration. Abundant external dressings are applied. The after-treatment is the same as that required for any other abscess. To the inexperienced it is astonishing at times to see the amount of pus obtained in such cases when there has been, as is commonly the case, no fluctuation and the tumor has been small. Cases such as have been described very frequently heal slowly, and most stubborn sinuses may persist and require subsequent operation. When healing takes place, the scars are not very resistant to pressure, hence post-operative herniæ are not uncommon.

If the appendix has not been removed when the abscess was opened, it ought to be sought and extirpated after recovery has been obtained. This secondary operation gives an opportunity to repair any hernia which may be present. It has been stated dogmatically that the appendix is absolutely destroyed in the vast majority of cases in which abscess has formed. Morison, however, finds that in 90 per cent. of instances the appendix is not destroyed but soon recovers after its contents have been discharged by sloughing or perforation.

The foregoing description of operation when large abscess is present presupposes the possibility of gaining access to the abscess without opening the peritoneal cavity. Frequently an abscess forms, is surrounded by adherent intestines, omentum, and a great mass of exudate, but is at no point adherent to the anterior parietes. To gain access to the *tumor* it is necessary to open the peritoneal cavity and the pus must be evacuated by the transperitoneal route. In such cases the abdomen is opened directly over the tumor; the relations of the tumor are discovered by the finger used with the utmost delicacy; the peritoneal cavity is most carefully and thoroughly protected by pads of gauze; a line of cleavage is found in the tumor and the finger is made to enter the abscess cavity. The opening into the abscess should not be made large *at first* or the whole wound and packing will be flooded by pus. It is desirable that the pus escape so slowly that it can be wiped away at once with gauze. After most of the pus has been removed, the opening into the abscess may be enlarged and the interior cleaned as well as possible with moist gauze. If

the appendix is easily found, it should be removed. Now, the abscess may be drained by a tube or loose gauze packing.

Operation for General Peritonitis Secondary to Appendicitis.—The object of operation is to prevent further leakage of septic material into the peritoneum, to remove as much as possible of the septic material already present, and to provide for drainage. The patients are suffering not merely from inflammation itself, but from shock and intense intoxication.

The Operation.—Make a large incision in the right inguinal region over the seat of the appendix. Remove the appendix. Frequently the inflammation has been so acute that no adhesions are present; if there are any, they should be broken down to permit of more thorough flushing. With wet sponges mop away all foreign material, such as fæcal concretions, etc., which may be found in the peritoneal cavity. Systematically douche the peritoneum with a large stream of hot normal salt solution. The solution should be of such a heat that the hand can be kept immersed in it without discomfort (118° F.). The solution may be poured from a pitcher, but it is better to conduct it by means of large tubing to the furthest recesses of the abdomen, so that the flow of contaminated solution may be outwards. When the solution returns clean, the abdominal subcavities—*e.g.*, Douglas's cul-de-sac and the subrenal cavities—are to be gently mopped dry with gauze pads. Drainage is provided for by glass or rubber tubes leading to Douglas's pouch. Abundant aseptic dressings must be applied. The external dressings will be found soaked with discharge in a few hours and must be changed. If a glass tube has been used, it must be aspirated at intervals of a few hours and removed generally in thirty-six to forty-eight hours.

Joseph A. Blake ("Transactions Am. Surg. Association," 1903) advocates early operation; lavage of the peritoneum with large quantities of saline solution; closure of the peritoneal cavity *without* drainage, unless the latter is absolutely indicated by the presence of non-absorbable amounts of necrotic material. Blake's published results are remarkably good.

One of the gravest dangers in generalized peritonitis is the absorption of toxins into the circulation. The peritoneum of the upper part of the abdomen has greater absorbing power than that of the lower, hence to let gravity aid in drainage and to hinder absorption as much as possible, Fowler recommends that patients be kept in an inclined position, the upper end of the bed being raised. The principle of this is admirable and good results have followed its use by most surgeons.

A method of operating followed by some surgeons in cases of early generalized peritonitis is to open the abdomen in or near the middle line. Guided by the hand inside the abdomen it is easy to make an opening about 1½ inches in length in each inguinal region and through these insert split rubber tubes containing strands of iodoform gauze. Rapidly cleanse the abdomen with salt solution and close the median wound. Return the patient to bed and keep him propped by bed-rest and pillows in a greatly exaggerated Fowler position. The results obtained are said to be excellent.

Le Conte ("Annals of Surg.," February, 1906), struck by the superiority of the results obtained by Murphy over those in his own very efficient hands, has adopted practically *in toto* the methods of the Chicago surgeon when dealing with diffuse septic peritonitis. The essentials of the technic are:

1. Rapid elimination of the cause of the peritonitis (gangrenous appendix, rupture of gut, rupture of pus tube, etc.). This with the *least possible handling* of the viscera.

2. Tubular drainage of the lowest portion of pelvis through a suprapubic opening and free drainage through the operative incision.

3. Elimination of all time-consuming procedures at the time of operating. Do *not* attempt to clean the peritoneum by mopping or flushing.

4. Fowler's position after operation.

5. Absorption of large quantities of salt solution through the rectum. This reverses the current in the lymphatics of the peritoneum, making the surface of that membrane a secreting instead of an absorbing one and this also increases the secretion of urine. Method of introducing the water into the rectum: Insert a nozzle *containing three or four openings* into the anus. Attach tubing of fountain syringe to nozzle. Fill bag of syringe with water and elevate it a few inches above plane of rectum, in fact only high enough to let the water *slowly trickle* into the rectum at the rate of about one pint per hour. Do not permit fluid to accumulate in the bowel, just introduce the water at the rate at which it is absorbed. Do *not* in any way interfere with the caliber of the tubing (this should be fairly large). It is very important that there should be a free exchange of fluid between the gut and the water reservoir. The level of the water in the reservoir should only be high enough so that the water in the rectum merely covers the end of the anal tube. If the intrarectal pressure increases (due to gas, etc.) the water in the rectum is pressed back into the reservoir, the gas, etc., escapes, and as soon as the pressure is relieved the water flows back into the rectum. Much ingenuity has been expended in devising means to regulate the flow of water into the rectum and to utterly spoil the simplicity and value of the Murphy method.

6. Prevent peristalsis by withholding all food or liquids by the mouth. Opium is objectionably but may be required.

H. F. Waterhouse (Lancet, Feb. 5, 1915) in acute peritonitis of almost any origin, advocates the local use of ether. (In this he follows Morestin). After opening the abdomen and treating the initial lesion, pass a rubber drain into the pelvis. This drain must have two lateral openings near its pelvic end. Close the wound snugly around the drain. Through a funnel pour 2 to 3 oz. of ether into the abdomen by means of the tube. Clamp the outer end of the tube. After about 3 hours the clamp may be removed. Out of 59 cases of peritonitis treated as above there were but two deaths. In all the cases of appendicitis (24) the pulse rate was above 100; in several it was 120–140; many of them were examples of perforated or gangrenous appendicitis.

Johnson in 1906 (Crisler and Johnson, Southern Med. J., March, 1913)

began treating acute peritonitis by pouring into the abdomen, an alcoholic solution of iodine ($2\frac{1}{2}$ per cent. to 3 per cent.). Usually a quart of the solution is used—sometimes a gallon. The amount does not matter so long as it penetrates every infected part of the abdomen. The results reported by Crisler and Johnson are remarkably good. Fort (Am. Journ. of Surg., Feb., 1915) strongly indorses the iodine treatment.

When ought one to advise operation in appendicitis?

Many surgeons answer the above question in a most simple manner by saying, "When appendicitis is diagnosed then is the time to operate." Most surgeons are less radical. All surgeons approve of operating in the interval between attacks of chronic or relapsing appendicitis. In acute appendicitis all surgeons approve of operating while it is reasonable to suppose that the infection is confined within the appendix itself—*i.e.*, within thirty-six or even forty-eight hours of the beginning of the attack, *but the earlier the better*. All are agreed on the necessity of evacuating abscesses when symptoms of absorption are grave or increasing. In all other cases marked differences of opinion exist. The author's personal views are as follows, and are those common to many other operators:

1. If possible, operate within forty-eight hours of the inception of the disease. Within twenty-four hours is better than forty-eight, and within twelve hours is better than twenty-four. *The earlier the better.*

2. After the lapse of forty-eight hours it is safer to adopt Ochsner's plan of non-operative treatment. (Ochsner, "Clinical Surgery.") This consists in —(*a*) Rest in bed. (*b*) Avoidance of purgatives. (*c*) Absolute denial of food and drink to the stomach. (*d*) If nausea or pain is present, lavage of the stomach. To nervous patients give morph. gr. $\frac{1}{6}$ hypodermatically half an hour prior to lavage and spray or swab the pharynx with a local anesthetic. The patient should be in the lateral decubitus. (*e*) Exclusive rectal alimentation (one ounce of concentrated predigested food in three ounces of salt solution, every four hours).

The exceptions to this rule are cases in young children and in the aged. The former cannot give the assistance necessary; stomach lavage in them means a fight and consequently much danger from spread of infection. Further, the omentum in children is small and can do little to wall off the focus of infection. The aged bear confinement in bed badly and as a rule the whole treatment outlined is inapplicable to them. In these cases the surgeon should either operate at once or watch the case carefully and if improvement does not set in *promptly* or if the symptoms get worse, he should operate.

3. After the subsidence of the acute attack, where the temperature and pulse have become normal, when pain, tenderness, and muscular rigidity have disappeared and the bowels are acting well, without causing disturbance, then the interval operation ought to be performed. Many surgeons advise that a certain *definite* time be allowed to elapse between the attack and the interval operation, *e.g.*, four weeks, to permit of complete restitution of the normal conditions. This is a safe precaution, but a careful observer is able to form an

opinion of his patient's condition and operate when he thinks right without adhering to any such strict rule as to lapse of time.

4. When the case is seen too late for the early operation, and tumor is present and the pulse, temperature, and general condition of the patient indicate a dangerous amount of absorption; if the tumor is increasing markedly and there are signs of the infection spreading, no surgeon would hesitate as to operation. Interference is imperative. When, however, the tumor is not increasing or is decreasing and the temperature and pulse are moderate and in proper relation to each other, there is, on the whole, less danger in delay than in immediate operation. Such cases almost always improve under the Ochsner regimen to such an extent that a safe interval operation becomes possible. The most rigid adherence to the regimen and to rest is essential, otherwise a catastrophe may happen. The danger of immediate operation is not merely that of shock and of general peritoneal infection, but the manipulations necessary for the evacuation of the encapsulated pus inevitably open by channels by which toxins are absorbed in quantities which may be fatal. Nature, when aided by rest, can safely encapsulate, and ultimately remove, even considerable quantities of pus in the peritoneum. If at any time during the course of the disease it becomes apparent that the encapsulation is incomplete and that dangerous amounts of toxins are being thrown into the circulation, then immediate operation becomes imperative. The author is perfectly aware that this advice violates the great law "*ubi pus ibi evacuo*," and will not meet with the approval of the majority of surgeons, but its importance has been impressed on him by experience.

5. In cases of appendicitis with generalized peritonitis the general rule is to operate at once and thoroughly. Very excellent results have been obtained in this way by many thoroughly reliable surgeons. The author is compelled to admit that his recoveries have been few in the cases on which he has operated under these conditions, while of the cases which refused operation a considerable number (too many to be all examples of mistaken diagnosis) have recovered most unexpectedly. Since adopting the Fowler or, better, the exaggerated Fowler position during after-treatment, the writer's results have improved immensely.

Remarks.—(The following remarks seem to the author logical but must be taken "with a grain of salt" as the whole subject discussed is at present in a state not remote from chaos.) On page 463 a reasonably large incision is strongly advised in operations for chronic appendicitis because the symptoms are so often due to other troubles unrelated to the appendix as evidenced by their persistence after the appendix is removed. Some of the anatomical conditions which may be found and which ought to attract the surgeon's attention are as follows:

1. Cæcum mobile with the neighboring ileum also mobile. This is perfectly normal and causes no trouble unless volvulus should develop as it may in the similarly mobile sigmoid loop.

2. Cæcum fixed; ileum mobile. Normal.

3. Cæcum mobile; ileum fixed by adhesions or by an ileo-pelvic band (Lane's kink). There may be intermittent or partial intestinal obstruction. Treat-

ment: (a) Mobilization of the ileum by division of the band and repair of the resulting wound in the peritoneum; (b) cæcopexy; (c) ileal mobilization plus cæcopexy; (d) ileo-sigmoidostomy (Lane).

4. Cæcum fixed; ileum fixed, the ileum between its point of fixation and the cæcum is angulated. There may be partial or intermittent obstruction. Treatment: (a) Mobilize ileum; (b) ileo-sigmoidostomy (Lane).

5. Cæcum mobile; ileum fixed; band across the ascending colon. Intermittent obstruction possible but unlikely. Treatment if required: Mobilize ileum; cæcopexy after placing the cæcum in proper relation to the ascending colon and the ileum.

6. Cæcum mobile and sunk down into true pelvis. Ileo-transversostomy (Wilms).

7. Cæcum mobile, much distended and atonic. Ileo-transversostomy (Wilms). Cæcoplication plus cæcopexy (Roeder).

8. Cæcum mobile; ileum mobile; band across ascending colon (Jackson's membrane). Possible obstruction by cæcum bending over the band or being pushed over it, *e.g.*, by pregnant uterus (?) (Fromme). Treatment if required: Division of the band or cæcopexy (Travel).

9. Band over ascending colon causing obstruction by compression. Treatment: Divide membrane or "dodge" the obstruction by ileo-transversostomy or ileo-sigmoidostomy.

10. Kinking at hepatic or splenic flexures with union of the ascending or descending colon to the corresponding portions of the transverse colon. Partial or intermittent obstruction. Treatment if necessary—short circuit by suitable anastomosis, *e.g.*, ileo-sigmoidostomy.

11. Kinking by so-called meso-sigmoiditis or deposits of scar tissue on the external surface of the meso-sigmoid, may give rise to volvulus requiring resection of the involved gut or anastomosis between the afferent and efferent loops. After ileo-sigmoidostomy Lane thinks a "kink" above the site of anastomosis is valuable in preventing reflux of fæces into the descending colon and he sometimes creates such a kink by sutures.

12. No anatomic conditions may be found to account for the symptoms which may be due to faulty habits of life leading to auto-intoxication with its sequelæ. For such patients medical treatment alone is indicated unless such treatment may be aided by flushing the colon by means of cæcostomy or appendicostomy or possibly by Lane's ileo-sigmoidostomy.

TUBERCULOUS PERITONITIS

When tuberculous peritonitis is not a mere phase in the history of a general tuberculosis, it is usually a reaction against infection coming from a tuberculous Fallopian tube; from a tuberculous stenosing ulcer of the ileum; from a tuberculous tumor of the ileum and cæcum; from a tuberculous vermiform appendix. Tuberculous peritonitis is much more common in the female, as the Fallopian tubes are the favorite sites for primary intraabdominal lesions.

Accidentally it was found that mere abdominal incision and evacuation of

ny ascitic fluid present, with or without subsequent drainage, led to recovery n many cases. Veit believes that 50 per cent. of the cases are cured and 25 per cent. improved after the above treatment, the curative agent being serum, fused as a result of the operative interference, acting as an antitoxin.

The most favorable cases are those in which ascitic fluid was *removed* during the operation, hence it is difficult to imagine the above theory correct. J. B. Murphy observed that where the end of the diseased Fallopian tube was patent, peritonitis was progressive, and where the ostium was closed by adhesions, etc., the peritonitis became stationary or was cured. Mayo came to the conclusion that in the presence of ascites the fimbriated extremity of the tube was mechanically kept patent, the fimbriæ being kept from adhering to each other and to neighboring structures, and hence the infective contents of the tube could constantly or intermittently leak into the peritoneal cavity. This gives a feasible explanation as to why simple laparotomy with removal of ascitic fluid often results in the cure of tuberculous peritonitis; the end of the tube, no longer buoyed up by the fluid, becomes closed, either by the fimbriæ adhering to each other or to neighboring structures. The primary lesion thus becomes encapsulated, and the peritoneum, being very resistant to tuberculosis, recovers. It has long been known that the cases accompanied by ascites are the ones most benefited by surgical interference.

Primary tuberculous lesions in the ileum have a great tendency towards spontaneous recovery; in these, when operation is demanded, it is to overcome resultant stenosis.

The tumor-like tuberculosis of the ileo-cæcal region has likewise a predisposition to cure. Both in the case of disease of the ileum and of the ileo-cæcal region the presence of ascites is well calculated to prevent the formation of protective adhesions around the focus of disease, hence the simple removal of the fluid may result in efficient encapsulation of the primary focus.

Baisch ("Munch. med. Woch.," 20 Aug., 1907) reports the results in one hundred and ten cases of tuberculous peritonitis observed from four to ten years in the Tübingan gynecological clinic.

1. **Pure Exudative Form.**—Thirty-eight cases; thirty-four submitted to operation, twenty-two cured, twelve of those operated on died in from three months to four years.

2. **Dry Adhesive Form.**—Twenty-two cases; eleven submitted to operation, eight of whom remained well, a few of these recovered only after a long illness and two had fecal fistula which closed after some months.

3. **Tuberculous Adnexæ.**—Forty-five cases; thirty-two submitted to operation with good results (eighteen cured; five in which one tube was left required secondary operation). Do not leave an apparently healthy Fallopian tube. Leave the uterus and if an ovary appears healthy it may safely be left.

Operative Treatment.—It is presumed that the diagnosis of tuberculous peritonitis has been made, but the site of the primary lesion is unknown.

Step 1.—Open the abdomen, in the female, by median, in the male, by **right rectus, incision.** Evacuate any fluid which may be present.

Step 2.—If in the female, examine the Fallopian tubes. This must be done with enormous caution in the presence of many adhesions, as it is easy to tear into a gut. If the necessary manipulations are very difficult, the dangers from injury to the gut outweigh the advantages of a radical removal of the primary focus, and it will be wise for most surgeons to trust to the encapsulation of the disease which is likely to result.

If safe, removal of the tubes is, of course, the procedure of choice. In any case examine the favorite sites of tuberculous lesions. Remember that what may appear a simple chronic appendicitis may be tuberculous, and that with the appendix any enlarged glands in the mesenteriolum ought to be removed. When there is a stenosing ulcer of the ileum, an anastomosis between the afferent and efferent segments of gut is all that is commonly required. If the diseased segment of gut is limited in extent and easily excised, its removal is proper, though not imperative.

The tumor-like tuberculous lesion of the ileo-cæcal region ought to be excised if this is fairly easy; if difficult, then that segment of the gut may be "segregated" or left to the curative powers of nature, assisted by the abdominal incision.

M. H. Richardson writes: "When, therefore, I have found a tuberculosis limited to a single coil of intestine, rather than excise that coil, except when stricture is present, I have contented myself with the exploration and demonstration of the disease. If the area affected has been one that could be easily and safely removed, I have removed it, as in tuberculosis limited to the appendix or to the Fallopian tubes."

In one case operated on by the author three enlarged lymph nodes, one the size of a hen egg, existed in the mesentery of the ileum. There was no evident disease of the gut. Incision through the superficial layer of the mesentry permitted the easy enucleation of the diseased structures, after which the mesenteric wound was sutured. Recovery.

Any tuberculous abscesses encountered should be evacuated, dried, iodoformized, and *not* drained.

Step 3.—Close the abdomen, preferably without drainage. The use of a drain is liable to lead to secondary infection and fæcal fistula.

CHAPTER XXXVI

THE RECTUM

Imperforate Anus.—There are two forms of imperforate anus, (A) No anal depression is present; (B) an anal depression is present, but does not open into the rectum.

(A) The anal depression is absent.

The Operation.—Place the child in the lithotomy position. Draw off the urine with a catheter. Do *not* keep the patient *deeply* anesthetized, as its attempts at crying and struggling press the gut downwards and aid the surgeon in recognizing the gut when he approaches it. Of course, enough anesthetic should be given to prevent suffering.

Step 1.—Make an incision in the median line from the middle of the perineum to the tip of the coccyx. Penetrate the skin and the musculo-aponeurotic floor of the pelvis. Frequently the gut will now present and be recognized from the dark blue color given it by the contained meconium. If the gut is not found, retract the walls of the wound. Note the position of the bladder—if necessary, introducing a sound into the bladder for this purpose. Deepen the wound by blunt dissection, following the concavity of the sacrum to its promontory. If the external wound is too small to permit of such deep dissection, continue the original incision backwards over the lower end of the sacrum and excise the coccyx and lowest segment of the sacrum. When the neighborhood of the gut is reached, if the child cries, an impulse will be communicated to the palpating finger. If the child is too deeply anesthetized to cry, intermittent firm pressure on the abdomen may give the same result. The gut having been found, separate its lower end as freely as possible from its surroundings.

Step 2.—When the gut is found to be superficial, seize it with a couple of small volsellum forceps or pass a suture through it for purposes of traction and pull it downwards to the skin, separating its lateral adhesions as traction is being made. With a knife cut into the gut. Meconium at once escapes and must be washed away by a stream of warm water. Clean out the gut by means of injections of warm water until the water returns clear. Cleanse the wound with a mild antiseptic solution.

Step 3.—Carefully and accurately suture the opening in the gut to the skin with interrupted sutures. Close the remainder of the wound with such deep and superficial sutures as may be required.

When the gut is more deeply situated, the technic is rendered much more difficult. It may be impossible to bring the gut down to the skin before evacuating its contents. In such a case, fix the gut with sharp hooks or forceps, open

it with a knife, and by means of a catheter douche out its contents. When the gut has been emptied, it is often possible to separate it from its lateral connections and bring it down to or near to the skin. When possible, the edges of the opening in the gut must be accurately sutured to the skin, as already described.

Should the rectum be entirely absent, the peritoneal cavity may be opened through the perineal wound and the first loop of gut which presents (generally the sigmoid) brought down, opened, and sutured to the skin (Stromeyer). In cases of failure to find the lower end of the rectum through the perineal route Macleod recommends that the abdomen be opened, the lower end of the *blind* rectum found, rendered mobile, and pushed downwards into the perineal wound, where it is treated in the manner already described.

(B) The anal portion of the gut is present, but is not joined to the rectum.

By palpation and inspection find if there is only a thin diaphragm separating the rectum from the anal gut or depression. If this is so, perforate or excise the diaphragm. If, as is often the case, much tissue is interposed, make an incision in the middle line from the anal depression or gut to the coccyx, deepen the incision as may be required, and proceed as if no anal gut were present, except that after the rectum has been opened and evacuated, its opening should be sutured to the anal gut instead of to the skin.

When none of the methods described is successful, or if the condition of the patient is such as to render the operation hazardous, it is proper to make a permanent or temporary artificial anus in the inguinal or lumbar region. Should it seem advisable, the perineal operation may be attempted on a later date.

Prolapsus Recti.—Rectal prolapse may be of two forms: in one form the rectal mucous membrane alone is protruded through the anus; in another, the rectal walls are more or less prolapsed. The prolapsed tissue may be reducible or irreducible; in the latter case it generally shows evidences of past and present inflammation. The prolapse may be due to atony or dilatation of the sphincter, or to a lack of support to the gut from above. Prolapse may be an accidental concomitant of a rectal tumor, the weight of the tumor dragging the gut down. Comparatively recently the main active treatment of rectal prolapse consisted in chemical or thermal destruction of protruding mucous membrane or of portions of the dilate anus, the scar contraction incident to healing leading to narrowing of the anus and support of the gut. Strangulation of the protruding tissues by means of ligatures was also recommended and often gave good results. All such measures ought to be discarded, as chemical and thermal action is difficult to regulate and the strangulation by ligature is distinctly dangerous. There are three distinct principles, each of which is the base is of a modern method of operative treatment.

1. When the prolapse is due to sphincteric atony or looseness, the principle of treatment is to overcome this condition by narrowing the sphincter.

2. When the prolapse is due to want of superior support, such support must be provided.

3. When there is excess of rectum and much tissue is prolapsed, the protruded mass should be excised. Generally this excision must be supplemented by narrowing the sphincter.

It must be remembered that very many cases of prolapse, and in children even severe cases, may be cured without operative interference.

Plastic Operation on the Sphincter Ani.—I. *Duret's Operation.*—From the posterior surface of the rectum remove a triangle of mucous membrane. The base of the triangle is at the muco-cutaneous junction; the apex is directed into the gut. From the skin behind the anus remove a similar triangle having the same base as the former, but having its apex directed towards the coccyx. A lozenge-shaped raw surface is thus formed partly involving the skin and partly the mucosa. By deep dissection cut away a wedge of the tissues exposed by the removal of the skin and mucous membrane. With the wedge of tissue a portion of the sphincter is excised. Insert deep and superficial sutures and close the wound. It is a wise precaution to unite the divided ends of the sphincter by one or more interrupted buried catgut sutures. In one case of particularly flaccid anus Duret has performed the above operation both posteriorly and anteriorly. The operation must be done under the most painstaking aseptic technic. This is of great moment in all the plastic operations above the rectum and anus.

II. Duret's operation may be modified as follows: Make a curved transverse incision following more or less closely the muco-cutaneous junction at the posterior side of the anus. Through this incision, with scissors or knife dissect the mucous membrane from the posterior anal wall until a point is reached above the sphincter. Excise a sufficiency of the sphincter and with catgut sew the divided ends together. If necessary, excise a portion of the reflected flap of mucous membrane. Close the superficial wound. This operation is only feasible if the prolapse can be reduced.

Operations to Narrow the Rectal Lumen and thus Prevent Prolapse.—*Lange's Operation (Transverse Rectorrhaphy).*—Make an incision in the middle line from a point immediately behind the anus to the base of the coccyx. Do not injure the sphincter. Resect the coccyx. By dissection expose the posterior surface of the rectum. Introduce a number of sutures into the gut wall in the Lembert fashion, transversely, as if closing a longitudinal tear in the rectal wall. The sutures must *not* penetrate the mucosa. Tie the sutures. The result is to narrow the gut by throwing its posterior wall into a longitudinal fold. Close the external wound by deep and superficial sutures.

Rectopexy.—(A) *Verneuil's Operation.*—With a knife trace a triangle having its base at the anus, its apex at the tip of the coccyx. Excise this triangle of tissue and with it the whole segment of sphincter corresponding to its base. Pass a long suture transversely through the posterior wall of the exposed rectum, without penetrating the mucosa. Arm each end of the suture with a needle. Push the needles through the tissues of the back, from within outwards, to emerge through the skin, one on each side of the sacrococcygeal articulation. At lower levels introduce three other sutures in a similar manner.

Tie the sutures. This narrows the anus and pulls the lower rectum backwards and upwards.

(B) *Marchant's Operation.*—Expose the posterior surface of the rectum by means of a median incision from behind the anus to the tip of the coccyx. Introduce several rows of sutures in the long axis of the gut after the Lembert method, as if to close a series of transverse ruptures of the gut. The sutures must not penetrate the mucosa. As each row of longitudinally placed sutures is tied the posterior wall of the gut is thrown into a series of transverse folds, which shortens it. With catgut unite the lowermost fold to the tissues immediately in front of the coccyx. Give additional support by introducing one or more sutures after the method of Verneuil described above. Close the wound completely.

Colopexotomy (*Jeannel's Operation*).—The object of this operation is to attach the sigmoid flexure to the abdominal wall and so give superior support to the rectum. The scope of the operation must be limited. In Garrè's clinic 59 per cent. of relapses followed the operation or some modification of it. (Pachnio, "Beiträge z. klin. Chir.," xlv, 300.)

The Operation.—Open the belly as in left inguinal colostomy. Seize the sigmoid flexure and pull it up until the rectal prolapse is reduced. Suture to the abdominal wound the lowest portion of the gut which can conveniently be brought into it after reduction of the prolapse. Make an artificial anus. After the gut is securely attached to the abdominal wall, and the rectum, irritated and inflamed because of having been prolapsed, is healed, the artificial anus may be closed.

McArthur's Operation.—Abdominal rectopexy. Principles of operation: (1) Obliterate the dilatation of Douglas' pouch which is always present. (2) Perform a rectopexy by uniting the rectum to a fixed portion of the sigmoid. (3) Avoid dangers from recto-sigmoid kinking by making an anastomosis between the rectum and sigmoid. The anastomosis should be made with three lines of suture so as to assure unusually thorough union. (4) If necessary repair the pelvic floor, *e.g.*, by Marchant's method.

Step 1.—Trendelenburg position. Open the abdomen in the middle line below the umbilicus.

Step 2.—Seize the rectum and pull it upwards until the prolapse is completely reduced. Note that the lower part of the peritoneum of Douglas' pouch cannot be put on the stretch no matter how strongly one may pull up the gut. Obliterate the relaxed lower segment of Douglas' pouch by suturing its walls together. This is as important as obliterating the sac of a hernia.

Step 3.—To the upper portion of the rectum apply an intestinal clamp. Choose a portion of the upper sigmoid, or of the junction of the descending colon and the upper sigmoid, which is well fixed to the posterior abdominal wall (*i.e.*, which is well supported superiorly) and yet which can be easily brought into apposition with the chosen portion of rectum. Apply an intestinal clamp here. Make a large lateral anastomosis between the chosen segments of rectum and sigmoid. Remove the clamps.

4.—Close the abdomen. If necessary the anal opening may be nar-
: a subsequent operation.

.u and Duval ("Rev. de Chir.," Feb., 1910) describe a very elaborate f obliterating Douglas' pouch; suturing the lower pelvic colon trans- :o the back of the broad ligaments and vaginal dome (to the back of der in the male); the upper part of the colon to the exposed tendon of s parvus. Fig. 593 explains the operation.

;ion of the Prolapsed Gut.—A considerable number of methods have rised for the removal of the prolapsed mass. Several of the methods ecognize the existence of a peritoneal pouch between the inner and

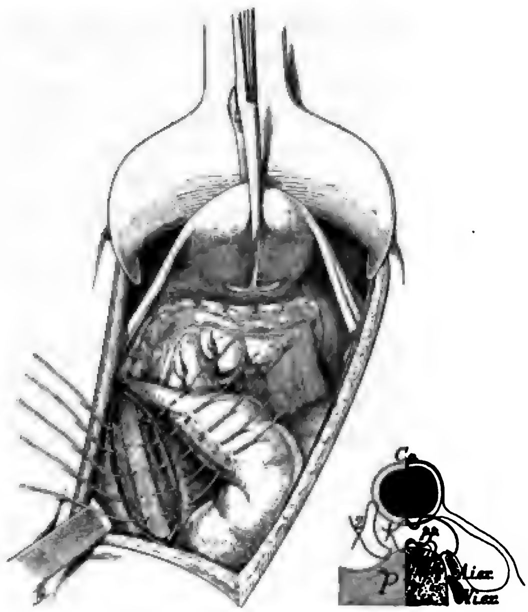


FIG. 593.—(*Quénu and Duval.*)

.be of the intussuscepted gut and that a loop of small intestine may :nt in that pouch. This failure renders all such methods too dan- o be justifiable, and they will not be here described. Excision should ved for gangrenous, irreducible or ulcerated cases as it has a death rate r cent. and there are at least 7 per cent. of recurrences.

ılicz's Operation.—Place the patient in the lithotomy position at the the table. Make a horizontal incision through the anterior half of rnal tube or cylinder of gut, *i.e.*, into the peritoneal pouch. Explore ch with the finger and reduce its contents if there are any. Suture, ,embert method, the peritoneal surface of the outer tube to that of the be (Fig. 594). Cut away the gut corresponding and peripheral to the ıture. Cover the line of suture by a row of stitches uniting the mucous ne of the outer to that of the inner tube. The posterior half of the

prolapsed gut must now be attacked in the same manner and the outer and inner tubes united by a row of Lembert sutures protected from contamination by some stitches which involve the mucosa alone.

To be successful the above operation must often be supplemented by a plastic operation on the sphincter such as has already been described.

Stricture of Rectum.—I. When a rectal stricture is soft and can be reached through the anus, treatment by gradual dilatation should be attempted.

Introduction of Rectal Bougies.—Place the patient on his left side with the right thigh partially flexed. Introduce the index finger through the anus and locate the opening through the stricture. If the stricture is large enough to permit the passage of the finger without force being employed, the finger may be used as a bougie. If the stricture is either narrower or much wider than the finger, use the finger as a guide and pass a well-oiled soft-rubber rectal bougie through the constriction. *No appreciable force must be used.* Leave the bougie in place for two or three minutes and withdraw it. Repeat the operation after the lapse of from one to four days, *i.e.*, after any irritation produced by the operation has subsided. At each operation it may be necessary to pass several instruments of different sizes, the last one being the largest which it is possible to introduce through the constriction without force. The principle of treatment is identical with that of gradual dilatation of urethral stricture. As in the case of the urethra, some rectal strictures are too irritable to permit of gradual dilatation. When suitable, the treatment is safe, but it is only palliative, as the contraction recurs when dilatation is discontinued.

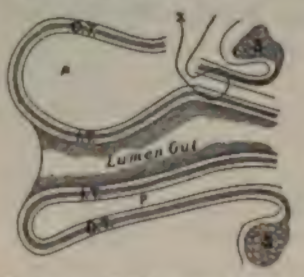


FIG. 594.—Prolapsus of rectum. O. T. Outer tube of gut. I. T. Inner tube of gut. P. Peritoneum. S. Sphincter ani. X. Suture.

II. *Credé's Operation.*—If the stricture is firm and resistant to gradual dilatation, Credé's operation may be useful. Administer an anesthetic. Guided by the finger, pass a probe-pointed knife through the stricture and with it make a number of small cuts or "*nicks*" in the protruding edge or ring of the stricture. Six or eight of these cuts may be made, none of them deep enough to endanger the peritoneum. Remove the knife and gently introduce a bougie. The rest of the treatment is that of gradual dilatation.

Forcible dilatation has been practised, but has proven too brutal and dangerous. It is unjustifiable.

III. *Posterior Rectotomy.*—Place the patient in the lithotomy position. Guided by the finger, pass a probe-pointed bistoury through the stricture and divide it completely in the middle line posteriorly. Continue the incision downwards and backwards so as to divide the sphincter ani. The result of this cut is the division of the stricture, the rectal wall below the stricture, and the sphincter, in the posterior median line. Attend to hemostasis. Pack the wound. The after-treatment consists in frequent changes of dressings, in careful cleansings, and subsequently in the use of rectal bougies.

IV. *Pean's Modification of Posterior Rectotomy.*—Make an incision in the

middle line of the posterior wall of the rectum from a point three-fourths of an inch above the stricture to and including the sphincter ani. Continue the incision backwards in the middle line until the incision through the skin equals in length that through the mucous membrane of the rectum. Pull the mucous membrane at the upper angle of the wound downwards and suture it to the skin. To render the mucous membrane movable, it may be necessary to undermine it slightly. The principle of the operation is to convert the original vertical wound into a transverse one and so gain room.

V. *Sonnenburg's Operation.*—Expose the gut by Kraske's method (page 483). Divide the stricture, vertically, taking care to avoid injuring the sphincter. Pack the wound. Healing takes place very slowly; fistulæ are almost certain to persist, and after-treatment with bougies is necessary.

VI. *Sokoloff's Operation.*—This operation is the same as Sonnenburg's, but instead of packing the wound, the vertical incision is converted into a transverse one by means of sutures. In suitable cases this operation is one of much promise, but cases suitable for it must be exceedingly rare.

VII. *Excision of the Stricture.*—The stricture may be excised in various ways. The methods of rectal excision are described elsewhere. It was hoped that excision, though dangerous, might prove an entirely reliable means of treatment. Experience seems to show that it is little better than a means of palliation.

VIII. *Colo-rectostomy.*—When the stricture is seated high up in the rectum, an anastomosis may be made between the colon and the rectum so that the intestinal contents may pass around the stricture.

IX. *Colostomy* may be used in the treatment of rectal stricture for two purposes: (*a*) To give relief from the obstruction; (*b*) to give rest to the rectum and to permit of local operations or treatment being carried out without interruption from fæces. In this case after the rectal disease has been cured the artificial anus may be closed.

The methods of performing colostomy are described elsewhere.

Excision of Rectum.—Excision of the rectum is most commonly indicated in cases of malignant tumors. When performed for the relief of rectal stricture (non-malignant), the operation is identical, except that in this case it is not necessary to excise the disease so extensively.

Preliminary Treatment.—Two main indications must be observed, viz.: (1) Improve the general condition of the patient; (2) diminish the septicity of the intestine.

The general condition may be improved by means of proper regulation of the organs of elimination and of proper regulation of the diet. A diet of eggs and milk is highly to be recommended. How may the septicity of the gut be diminished? The only efficient medicinal means of cleansing the rectum is purgation. But it is easy to carry this means too far and weaken the patient. The moderate use of salines or of calomel is highly proper. For Tuttle's method of cleaning the rectum see page 508. Various antiseptics have been administered by the mouth, in the hope of lessening the filthiness of the rectum (resorcin, salol,

etc.), but in the opinion of the writer such endeavors must be as futile as an attempt to antisepticize the Mississippi River at New Orleans by pouring a barrel of corrosive sublimate into its current at St. Paul.

Apart from moderate purgation, the only possible means to approximate cleanliness in the lower bowel is flushing and scraping.

Flushing the Rectum.—Pass a long, soft, flexible rubber tube into the rectum and through the stricture. Through a funnel on the proximal end of the tube pour warm water or boracic acid solution into the gut until the patient experiences a feeling of discomfort. Lower the funnel and tube, and permit the water to flow into a receptacle on the floor. Repeat the operation. Carry out these rectal flushings every morning and evening for four or five days before the operation.

Scraping the Rectum.—Immediately before the operation dilate the anus and scrape away all the friable surface of the cancerous growth with a sharp spoon, preferably with a flushing curette. The bleeding is trivial and soon stops. Should the hemorrhage not cease spontaneously and quickly, touch the bleeding points with a thermo-cautery or with liquid carbolic acid, preferably the former. Removal of the abominably foul surface of the cancer with a curette and thorough flushing of the rectum are undoubtedly the best means of diminishing the septicity of the bowel, but however thoroughly these means are used, the cleanliness obtained is only relative, though none the less important.

I. *Vaginal Route.*—In the female, when the anterior rectal wall alone is diseased, one may make a vertical incision through the posterior vaginal wall, expose the growth, excise it, suture the opening left in the rectum, and then separately suture the vaginal wound. Such an operation is not often suitable.

II. *Anal Route.*—(A) The anus is involved in the disease. Place the patient in the lithotomy position. Make an incision all around the anus. With blunt and sharp dissection separate the diseased anus and the rectum from their surroundings until a point in the rectum is reached about one and one-half inches above the disease. Divide the rectum at this point and remove the disease. Attend to hemostasis. Pull the edge of the divided rectum downwards and suture it to the skin, if possible. If the incision surrounding the anus does not give sufficient room for the next steps of the operation, one may supplement it by a median incision running backwards to the coccyx or one may even excise the coccyx. If it is impossible to bring the divided end of the rectum down to the skin at the site of the natural anus, it may be sutured to the skin at the level of the coccyx.

The operation as described is permissible only if the anus is diseased. The sphincter is sacrificed. Incontinence of fæces results. Delbet writes: "To avoid these inconveniences Witzel, on the advice of Willems, passes the end of the rectum through the fibres of the gluteus maximus. Rydygier through the pyriformis and gluteus maximus, Gersuny, before fixing the rectum, so twists it on its axis that its longitudinal muscular fibres play the rôle of sphincter, or at least offer some mechanical opposition to the escape of intestinal contents."

(B) The anus is *not* involved in the disease.

1. The disease is freely movable and only involves a small part of the rectal wall. Place the patient in the lithotomy position. Dilate the anus fully. Seize the tumor with a volsellum and pull it downward into a freely accessible position. On each side of and a little above the tumor seize the rectum with forceps or sharp hooks. The object of this is to prevent the wound being retracted out of easy reach after the tumor is removed. Freely excise the tumor. Close the wound with sutures after attending to hemostasis. When possible, it is wise to insert the sutures in the long axis of the gut so that the resulting scar is transverse and danger of subsequent stricture is lessened.

2. The disease is freely movable, is *very low down* in the rectum, but involves all or nearly all the circumference of the gut. Place the patient in the lithotomy position. Dilate the anus fully. Seize the tumor with volsellum forceps and pull it downwards into a freely accessible position. Make an incision completely around the anus at the muco-cutaneous junction. Separate the anal mucous membrane from the sphincter. When the upper edge of the spincter is passed, divide the whole thickness of the rectal wall and separate the rectum from its surroundings until a point is reached well above the disease. In cancer remove too much rather than too little. Attend to hemostasis. Divide the rectum above the disease and remove it. Pull down the divided end of healthy rectum and suture it to the skin.

III. *The Perineal Route.*—Place the patient in the lithotomy position. Make an incision in the middle line from the anus to the point of the coccyx. This incision divides the sphincter. Dieffenbach supplements the above cut by one placed in the middle line anteriorly which also divides the sphincter and reaches to the bulb of the urethra. Retract the edges of the wound. Separate the anal mucous membrane from the sphincter and proceed to remove the disease as described in the preceding paragraph. In dissecting the rectum free from its surroundings take special care not to injure the prostate or the base of the bladder; for this purpose it is wise to do most of the dissection with the finger or some blunt instrument. Should the bladder be torn, its wound must be closed at once by a few sutures.

The disease having been removed, pull down the divided end of the healthy rectum and suture it to the anal skin. Close the rest of the wound with deep and superficial sutures. The stitches should restore the integrity of the sphincter and do away with the presence of dead spaces in the depth of the extensive wound. If it is impossible to avoid the presence of dead spaces, such must be drained.

If, in order freely to excise the tumor it is necessary to open the peritoneum, do so, but before penetrating that cavity carefully wash the wound with an *antiseptic* solution and close the peritoneal wound with sutures at as early a stage in the operation as possible.

IV. *Sacral Route.*—Every method by which the rectum is removed via the sacral route is based upon the Kraske operation.

Kraske's Operation.—Place the patient on his right side with the thighs slightly flexed.

Step 1.—Make an incision in the middle line from the middle of the sac
to the anal margin. This cut penetrates to the bone but does not cut thr
the anal sphincter.

Step 2.—Detach the gluteus maximus on the left side from its sacral
coccygeal origins.

Step 3.—Excise the coccyx.

Step 4.—Close to the sacrum, cut through the lower part of the left sa
sciatic ligament.

FIG. 595.
A, B, C. Kraske's line of section. H, K. Heineke and Kocher's line of section.

Step 5.—With chisel or strong bone forceps excise the left half of that
of the sacrum lying below the level of the third posterior sacral fora
(A, B, C, Fig. 595).

Step 6.—Expose the rectum by dividing the soft structures lying bet
it and the sacrum. *Do not open the gut.*

Step 7.—Separate the gut from its surrounding by blunt dissection.
rectal mesentery having been loosened (bluntly), pull the gut downwar
such an extent that after the diseased section has been freely removed the
tinuity of rectum may be restored by sutures on which no unnecessary te
may be exerted. It is important not to have opened the gut, as in this st
the operation the peritoneum is ntly opened either by accident or de
If the gut is not opened and not invaded, the peritoneum mu

* Step 5 of Kraske's operation odified. It is found that much more
sacrum may be removed, when as been described above. The left h
the sacrum up to the second fora ised, the spinal canal opened, and the
fibres of the cauda equina remov esulting.

closed by sutures or packing (preferably by sutures) after the rectum has been pulled downwards to the desired extent. If the peritoneal wound has become soiled, owing to escape of intestinal contents from an accidental tear in the gut, it must be cleansed and drained with iodoform gauze.

Step 8.—At a point about one and one-quarter inches above the disease (if it is malignant; closer, if non-malignant) divide the gut transversely and remove it to a point the same distance below the disease. Suture the upper segment of gut to the lower.

FIG. 596.—Rehn's operation.

Step 9.—Cleanse the whole wound carefully. Diminish the size of the wound by a few stitches so applied as to avoid interfering with the freest possible drainage. Pack the rest of the wound loosely with iodoform gauze. The wound closes by granulation. A fæcal fistula frequently results, as the intestinal sutures, especially the posterior ones, commonly give way.

Kraske ("German Surg. Congress," 1906) thinks that laparotomy ought always to be practised as an immediate preliminary to the sacral operation in cases of extensive disease in order to permit removal of lymphatic nodes. He divides the gut with the cautery between two ligatures and thus renders the lower segment mobile and easy of excision through the sacral route.

Rehn's Modification of Kraske's Operation.—Instead of Kraske's median incision make a cut along the left side of the sacrum and coccyx and continue it towards the anus (A B, Fig. 596). If sufficient space is obtained by this incision, proceed with the other steps of the operation. If more room is required, make a transverse incision (B C, Fig. 596) over the sacrum between the third and fourth sacral foramina. Separate the sacrum from the soft

parts in front of it and divide the bone along the line of the transverse incision. Reflect the newly formed flap, consisting of sacrum, coccyx, and soft structures covering them, to the right.

The rest of the operation is practically identical with Kraske's, except that after the rectum is loosened from its connections and pulled down so far that the suture of the divided ends (without tension) will be possible after the tumor is removed, the whole wound is loosely packed with iodoform gauze and the rectum left unopened and not relieved of the tumor. During the after-treatment the patient must lie on his side. Keep the bowels locked up for five days with opium. On the fifth day move the bowels with castor oil and

FIG. 597.—Schlange's operation.

enemata. After the lapse of about ten days from the primary operation, excise the tumor and suture the ends of the gut together. In doing so, first stitch the mucosa with catgut and then unite the other coats with silk. It strengthens the line of sutures if the silk stitches include in their bite some of the neighboring soft parts.

It is claimed that, among other advantages, the operation in two stages lessens the immediate mortality of a very serious procedure—(*a*) because the shock is lessened, (*b*) because the huge wound cavity is well covered by granulations before there is much chance of its becoming soiled by intestinal contents.

A distinct disadvantage of Kraske's operation is that the levator and the sphincter ani muscles lose the support which they normally obtain from the sacrum and coccyx. This is important for the future comfort of the patient. In order to save the sacrum and coccyx Heineke and Kocher (Fig. 595) have

divided the coccyx and lower end of the sacrum longitudinally in the middle line and retracted the fragments to either side, replacing them when the operation was completed. Schlange has attained the same object by a method which affords much room and has given excellent results in his hands.

Schlange's Operation.—Step 1.—Make a transverse incision down to the bone across the lower part of the sacrum.

Step 2.—From the above incision make two others (one on each side of the coccyx) which diverge from each other slightly and end near the level of the anus. Near the anus these two cuts merely penetrate the skin, but where they skirt the coccyx and lower end of the sacrum they divide the muscles and ligaments inserted into these bones.

Step 3.—With a Gigli wire saw divide the sacrum transversely along the line of the original skin-incision (Step 1). Reflect downwards the flap of bone and superjacent soft parts formed by the preceding steps (Fig. 597). The rectum is isolated, tumor excised, and intestinal wound closed as in Kraske's operation. After attending to hemostasis the wound is loosely packed with iodoform gauze and the sacro-coccygeal bone-flap is partially replaced. The patient is kept on his side for a few weeks to avoid injury to the flap; the wound heals by granulation and the flap gradually assumes its normal position. Schlange was able to exhibit to the Berlin Medical Society a patient on whom he had performed the above operation six weeks previously with a result perfect as regards both comfort and function.

Kümmel no longer (1906) excises much bone, nor does he use large bone-flaps. He excises no more than the coccyx. Rotter does the same, but leaves the point of the coccyx with its muscular attachments. After dissecting free the diseased segment of gut Rotter, if possible, resects this segment and re-establishes the intestinal continuity. If resection is impossible he amputates the diseased and distal portions of the gut, and pulling the upper segment of gut through a tunnel bored through the glutei muscles, establishes a gluteal anus away from the large coccygeal wound. This little modification (establishment of gluteal anus) has been very life-saving.

Rotter's death rate has fallen from 32 per cent. before 1903 to 4¾ per cent. since that date. His late results have been very encouraging. (See "Centralblatt für Chir.," July 14, 1906, or "La Presse Medicale," July 21, 1906.)

W. J. Mayo's Modification of Kraske's Operation.—Place the patient in the Trendelenburg position, *but* on his face instead of on his back. The pelvis must be supported at the end of the table and the hips more or less flexed. The posture might be called the reversed lithotomy position.

Step 1.—Make a median incision from near the anus up to a point between the middle and base of the sacrum. Reflect the soft parts from the coccyx and the lower half of the sacrum. Divide the soft parts attached to the sides of sacrum and coccyx all the way around these bones from one sacro-sciatic notch to the other.

Step 2.—With a chisel divide the sacrum transversely at the second foramen;

i.e., at the level of the sacro-sciatic notch. Excise the lower part of the sacrum and the coccyx. The mid-sacral artery will require ligation.

Step 3.—Divide the levatores ani in the middle line. With a pledget of gauze wipe downwards the external and at least part of the internal sphincter to the anus, separating these structures from the mucosa of the gut. (It is assumed that the mucosa here is not involved in the disease.)

Step 4.—Mobilize the rectum above the disease. Open the peritoneum and pack it with gauze. Pull the sigmoid (pelvic colon) downwards. Ligate and divide the inferior mesenteric artery. Open the two folds of meso-rectum and wipe downwards all the fat and lymph tissue behind the rectum in the cavity of the sacrum. All the diseased gut now lies loose except at its upper and lower ends.

Step 5.—Pull the rectum upwards so that the anus is pulled inwards (or upwards). This is possible because the sphincters have already been separated from the anal mucosa. Clamp and divide the gut at the muco-cutaneous junction. The loosened sphincters lie below the clamp. Clamp and divide the gut well above the disease. Remove the diseased segment.

Step 6.—Bring the rectal stump downwards; pull it through the anus until it protrudes one inch. Fix it in position with safety pins. If there is tension on the gut, incise the peritoneum more freely at the sides as this is the supporting force.

Step 7.—For a distance of three inches upwards from the anus suture the levatores ani muscles together and to the posterior surface of the gut. (If the internal sphincter has been divided and preserved, suture it along with the levatores.

Remove the peritoneal packs. Attach the peritoneum to the gut with interrupted sutures. Provide ample drainage by means of split rubber tubes containing strips of gauze. Partly close the external wound.

After forty-eight hours remove part of the drains (all of them if the wound seems clean). Fill the wound with Van Arsdale's fluid (5 per cent. balsam of Peru in castor oil). Do not repack except to keep the external wound open.

Mummery's Method ("Brit. Med. Journ.," June 1, 1907).—Lithotomy position with pelvis raised on small hard cushion. (Combined lithotomy and Trendelenburg postures).

Step 1.—Wearing rubber gloves dissect a cuff of mucosa from the anal canal for about 2 inches, as in the Whitehead operation for piles. With sutures or clamp completely close this tube of mucosa so that nothing can escape from the rectum. With cautery or pure carbolic sterilize the stump. Change gloves and discard all instruments used. Once more cleanse the parts.

Step 2.—Make a median incision through the sphincters backwards to and little beyond the base of the coccyx. Remove the coccyx. Open the posterior rectal space and separate from the sacrum by gauze dissection all the glands, fat, etc., there present and push these structures forward in one piece along with the rectum.

Step 3.—Pull down the levator ani on each side with the finger. Divide

the muscle close to the rectum. Separate the rectum from the prostate and urethra (or from the vagina). This requires much care.

Step 4.—Open the pèritoneal cul-de-sac and divide the attachments of the peritoneum to the rectum first on one side and then on the other, keeping close to the rectum to avoid the ureters. This leaves the rectum free except for the meso-rectum.

Step 5.—Divide the meso-rectum as near the sacrum as possible after applying clamps or better suture ligatures. The rectum now comes down freely and the sigmoid presents. The lowest portion of the sigmoid is often provided with such a short meson that it cannot be brought to the anus without tension.

FIG. 598.—(*Mummery, "Brit. Med. Jour."*)

Divide the meso-sigmoid, after applying clamps or ligatures until a portion of the gut is reached with mesentery long enough to permit easy union of gut to skin (see Fig. 598).

The tumor and all the rectum are now outside the wound. Do not yet divide the gut.

Step 6.—Attend to hemostasis in a painstaking manner. Suture the peritoneum to the sides and front of the sigmoid. Close the wound after providing for "cigarette" drainage. Be specially careful to suture the sphincters accurately.

Step 7.—Divide the gut about 3/4 to 1 inch distal to the sphincter. Fix the edges of the divided gut by a few stitches *not* to the margin of the skin-wound but to the skin itself about 1 inch away from the wound. This greatly protects the wound against fouling. Later the excess of mucosa can be cut away. Introduce a short rubber tube into the bowel to permit passage of gas. Apply dressings.

Proust's Modification of Kraske's Operation.—Proust's account of this operation ("La Presse Med.," December 28, 1907) is so clear and so well illustrated that it would be unjust to that surgeon and to the profession not

to give a short description of it here. For two weeks before operation give repeated purgatives and enemata. Give a final purgative forty-eight hours before operation. Give opium sufficient to thoroughly constipate twenty-four hours prior to operation.

Place the patient on his left side, thighs slightly flexed and buttocks slightly over the edge of the table. The ventral position may be used.

Temporarily close the anus with a purse-string suture.

Step 1.—Same as in Mayo's method.

Step 2.—Divide the sacrum transversely, four fingers' breadth above the point of the coccyx, *i.e.*, on a line just below the third foramen. Remove the

FIG. 599.—Ligation of superior and middle hemorrhoidal vessels. (*Proust.*)

lower part of the sacrum and the coccyx. Ligate the mid-sacral artery which lies on the anterior surface of the bone. Apply moist, hot pads to the cut surface of bone to stop bleeding.

Step 3.—The retro-rectal cavity with walls smooth as a serous bursa, is now open. Carefully tear a hole in the anterior wall of this cavity, *i.e.*, in the aponeurotic sheath, and expose the posterior surface of the rectum, high up on which lie the superior hemorrhoidal vessels. Ligate these (Fig. 599). Enlarge the opening in the sheath downwards to expose the middle hemorrhoidal vessels. Ligate these (Fig. 599).

Step 4.—Bit by bit separate the rectum from its sheath and push it to the

left until the peritoneum appears at the upper part of the field. Open the peritoneum by a vertical cut in the middle line. Introduce the finger and hook it round the gut so that the point of the finger raises the peritoneum on the opposite side of the gut. Open the peritoneum here also. Pass a loop of gauze round the gut like a scarf for purposes of traction. Pack the peritoneum with gauze.

Step 5.—Pull the rectum, and with it the sigmoid, downwards. Successively ligate and divide the terminal branches of the inferior mesenteric vessels in the meso-sigmoid (Fig. 600). This dissection makes the descent of the sigmoid easy. Continue the dissection until the neoplasm and an ample

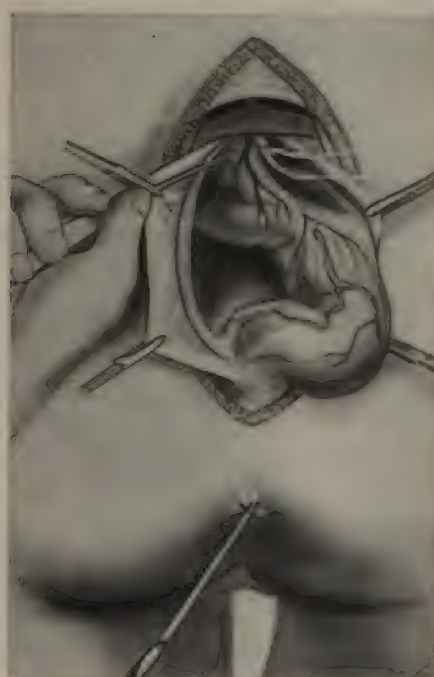


FIG. 600.—Ligation of branches of inferior mesenteric vessels. (*Proust.*)

sufficiency of healthy gut is delivered and until healthy gut above the neoplasm can be brought easily and without tension to lie against healthy gut below the neoplasm. With the gut bring away all the suspected lymphatic tissue of the meson.

Step 6.—Partially close with transverse sutures the vertical wound in the peritoneum. Make each suture pass through the meso-sigmoid above the part which has been ligated and divided but do *not* include any vessels within the sutures. Tie the sutures. This partly closes the peritoneum and it fixes the gut so that it cannot retract upwards (Fig. 601).

Step 7.—Apply rubber-covered intestinal clamps to the gut above and

below the lines chosen for division of the intestine. Lay the clamps along side each other and unite the anterior surfaces of the two loops of gut by a row of continuous Lembert sutures on the tumor side of the clamps. Apply crushing clamps to the two loops of gut between the line of Lembert suture and the neoplasm. Divide the gut and remove the neoplasm. The crushing clamps prevent escape of contents from the gut being removed. Complete the end-to-end anastomosis of the gut (circular enterorrhaphy) (Fig. 602). The anterior and part of the lateral surfaces of the gut are usually covered by peritoneum if the tumor is fairly highly placed and hence good serous apposition can be attained. The posterior surface is devoid of serosa and hence

FIG. 601.—Closure of peritoneum and fixation of gut. (*Proust.*)

union is less accurate. Proust therefore recommends that *no* attempt be made to cover this portion of the intestinal wound by gliding flaps of parietal peritoneum over it, but that the parietal peritoneum should be stitched to the gut in such fashion as to close the peritoneal cavity and leave the doubtful portion of the intestinal wound entirely extraperitoneal. If the tumor is found at too low a level to permit of safe end-to-end anastomosis the operation may be finished by Mayo's method.

Step 8.—Bring the edges of the skin wound together with stitches deep enough to catch up the subjacent tissues. Drain all dead spaces with loose gauze packing. Remove the purse-string suture which closed the anus temporarily. Apply dressings. Keep the patient constipated during one week.

Inguinal Colotomy as a Preliminary to Excision of the Rectum.—Should inguinal colotomy be performed as a preliminary to excision of the rectum? Quénu seems to consider that such is always advisable; other surgeons seem to consider that it is always needless. Probably the truth lies between these extremes.

Mummery considers colotomy unnecessary if it is possible to thoroughly empty the bowel of all retained fæces before operation so that one can be morally certain no fæcal material will find its way into the lower bowel for some days after the operation and the bowels can be prevented from acting for six or seven days. When the above cannot be accomplished preliminary colotomy is advisable.

FIG. 602.—Anastomosis of gut. (*Proust.*)

The disadvantages of a preliminary colotomy are mainly the following:

(*a*) The annoyance of an operation performed some days before the main intervention.

(*b*) The risk and annoyance of an operation performed to close the inguinal anus some weeks after the main intervention.

(*c*) Adhesion of the sigmoid flexure to the abdominal wall at the site of the artificial anus, interfering with the pulling down of the rectum necessary to excise the tumor and approximate the divided ends of the gut.

This is *the real* objection to the operation, but it may be overcome either by exercising care in choosing the part of the colon to be united to the abdominal wall or by making the artificial anus on the *right* side of the abdomen.

The main advantages of preliminary colotomy are as follows:

(*a*) Through the abdominal cavity one can explore the upper limits of an extensive cancer and observe the presence of serious lymphatic extension.

(*b*) One prevents the passage of fæces into the diseased rectum and can thoroughly irrigate it with solutions introduced either through the anus or through the colotomy wound. During the after-treatment one is not dependent upon opium as a means of keeping the wound free from fæcal contamination. With the aid of a preliminary colotomy it is easy at least to approximate cleanliness in an excision of the rectum.

What are the indications for radical operation in rectal cancer?

Whenever cancer of the rectum is diagnosed, it should be removed at once. Too much should be removed rather than too little. This should be the invariable rule except when the patient's local or general condition is such that the operation affords no hope of recovery, in which case palliative treatment, *e.g.*, by colotomy, must be initiated.

From careful examination of a rectum excised for cancer Sampson Hardley comes to certain conclusions which may be epitomized as follows ("Brit. Med. Journ.," April 16, 1910):

(*a*) That permeation of the growth may extend very widely in the mucous plexus upwards and downwards, reaching in a comparatively early stage of the disease a point at least 5 inches from the edge of the primary disease. The affected section of the bowel may appear quite healthy to ordinary macro- and microscopic examination (mucicarmine is a specific stain for cancer cells undergoing mucoid degeneration) because the permeating cells have undergone myxomatous degeneration.

(*b*) Permeation of the mucous lymphatic plexus as a factor in dissemination is probably limited in effectiveness by the habitual degeneration of the cancer cells in this situation.

(*c*) Cancerous infiltration in the muscular and peritoneal coats does not extend far from the primary growth.

(*d*) Effective dissemination probably occurs as a rule through the meso-rectum or peri-rectal tissue opposite the primary growth and hence this tissue must be removed.

(*e*) Because of the permeation referred to in (*a*) a great length of bowel should be removed including the sphincters.

A few years ago cancer of the rectum was considered beyond remedy by operation if the upper limits of the tumor could not be reached by the finger passed through the anus. Mere extent of tumor along the gut no longer contraindicates operation. Extension of the tumor through the intestinal walls and involvement of neighboring tissues is a matter of great import. As a general rule, it may be said that when the tumor has become absolutely immobile, the disease is so widespread that operation is worse than useless; that when the immobility is only partial it may possibly be due to simple inflammatory adhesions, and operations may be justifiable, though exceedingly dangerous. Esmarch does not consider involvement of the base of the bladder

in the cancerous process a contraindication to operation—he boldly excises the diseased bladder-wall and sutures the defect. Extensive involvement of the pelvic lymphatic glands is a contraindication to operation which can rarely be utilized unless the abdomen is explored. If one practises preliminary colotomy, one has the opportunity to examine the pelvis before fixing the colon to the belly-wall.

Choice of Operation.—In most cases where the tumor is well within the reach and its uppermost extenson can be easily palpated by the finger introduced through the anus, the operation through the anus or perineum may be chosen. In such localized and easily surmounted tumors the results are excellent.

Kelsey writes: "The advantages of the sacral incision may be briefly enumerated as follows:

"1. To dissect methodically cancers situated high up, and preserve the sphincters.

"2. To completely remove cancers distinctly circumscribed, but which would be inoperable by the older methods, their upper limit being beyond the reach of the knife.

"3. To preserve, in whole or in part, the external sphincter, even when the rectum is involved low down.

"4. To avoid the formation of a cloaca, even when the rectovaginal septum is invaded by the disease.

"5. To attack recurrent growths while yet limited, and give to the sufferers one more chance of health.

"6. Finally, to render more easy and precise the extirpation of non-malignant strictures."

Combined Abdominal and Perineal Rectectomy.—*Quénu's Method.*—*Step* 1.—Place the patient in Trendelenburg's position. Open the abdomen in the middle line below the umbilicus.

Step 2.—Ligature of both internal iliac arteries. (This is for the control of the middle and inferior hemorrhoidals.) Note the inferior border of the promontory of the sacrum; on each side of this can be felt the pulsation of the internal iliac arteries or of the common iliac if the division has not yet taken place. At this level, 1¼ inches (3 cm.) from the middle line and a trifle to the inner side of the pulsating artery, place the middle of a 2-inch incision through the peritoneum alone. By blunt dissection retract the outer lip of the peritoneal wound and with it the ureter. Expose the common and the external iliac arteries. A little downwards and inwards expose the internal iliac and ligate it at a point a little more than ½ inch below the bifurcation (Fig. 603). On the left side the ligation is not so easy on as the right, because the origin of the meso-sigmoid hides the vessels. Two methods are possible: (*a*) Preferable when the meso-sigmoid is short. Lay the sigmoid flexure against the iliac fossa; make an incision, symmetrical to that on the right side, so as to get through the meson and expose the parietal peritoneum. Incise the exposed peritoneum, retract the outer lip of the peritoneal wound, and proceed to the ligation as on the right side. (*b*) If the meso-sigmoid is very long, pull the

sigmoid upwards, incise the parietal peritoneum immediately below the origin of the meson, and thus reach the vessels directly. When it is evident that the ligation of the left internal iliac will be difficult, it is simpler to put this step off until after the sigmoid has been divided and the field of operation has been made easier of access. While the iliac vessels are exposed, examine this region for

FIG. 603.—Ligation internal iliac artery. (*Monod and Vanverts.*)

FIG. 604.—Quénu's operation. (*Monod and Vanverts.*)

enlarged lymphatic glands. Close the wounds made in the peritoneum over the arteries.

Step 3.—At a point free from blood-vessels tear a hole in the meso-sigmoid and pass a large strip of gauze through it (Fig. 604). Protect the abdominal cavity with gauze pads. With the fingers empty the contents from that portion

of the sigmoid opposite the tear in the meson. Doubly ligate the gut and divide it between the ligatures, preferably with the thermocautery. Cover the divided ends of gut with gauze and rubber caps held in place by a thread or a rubber band. This to prevent soiling. Working downwards from the tear in the meso-sigmoid, divide that structure between forceps or ligatures and push aside temporarily the lower segment of gut Sudeck's illustration (Fig. 605). ("Muench. med. Woch.," July 2, 1907) gives a very clear idea of the inferior mesenteric artery. It is best, if possible, to ligate the artery after it gives off its last important anastomotic branch, *i.e.*, when the ligation is for hemostasis and not for mobilization.

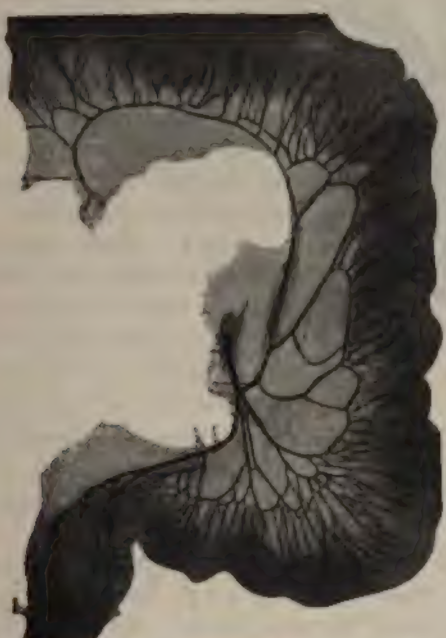


FIG. 605.—Inferior mesenteric artery. (*Sudeck.*)

Step 4.—Make an incision in the left iliac region through the parietes (Fig. 606) and pull the divided end of the upper segment of gut through this.* Fix the gut in position by a few sutures. A permanent artificial anus is thus provided. For Handley's modification see p. 512.

Step 5.—Pull the lower segment of gut (viz., that to be removed) forwards and upwards against the pubis. Divide the meso-rectum and ligate the hemorrhoidal vessels. When the posterior connections of the rectum have been separated, proceed to incise the recto-vesical *cul-de-sac* if this is possible of access. Lay the whole lower segment of gut, well covered with gauze pads, in the deepest part of the pelvic fossa. Completely close the abdominal wound, after as

* This incision is best made in exactly the same way as in McBurney's muscle-splitting operation of appendectomy.

far as possible diminishing the peritoneal laceration by means of sutures applied to the remnants of the meso-rectum.

Step 6.—Place the patient in the lithotomy position and complete the operation by removing the loosened rectum and its protecting pads of gauze by the perineal route, if necessary excising the coccyx and portions of the sacrum. Provide for perineal drainage and close the perineal wound with sutures.

Step 7.—According to circumstances, either leave the portion of gut which has been fixed in the left iliac region untouched for two or three days or open it immediately so as to empty the bowels. In the formation of the artificial anus the use of Paul's tube will aid in preventing soiling of the dressings.*

FIG. 606.—Quénu's operation. (*Monod and Vanverts.*)

Modified Quénu Operation.—Step 1.—Place the patient in the high Trendelenburg position. Open the abdomen in the middle line below the umbilicus. Examine as to the possibility of removing the disease. Protect all the intestines with gauze pads, leaving the sigmoid and rectum free.

Step 2.—Apply two clamps to the gut well above the disease and divide the gut between them. Close each end of gut by a row of through-and-through sutures. Invaginate the stumps into the lumen of the gut by a purse-string suture as in appendectomy. Leave uncut the suture attached to the upper segment of gut; apply a hemostat to the end of the suture; the suture will act as a guide to the gut later.

Step 3.—Pull the end of the lower segment of gut up into the wound. On each side of the gut make a cut through the peritoneum of the meson parallel to the gut and strip back the peritoneum. If the lower part of the sigmoid forms a part of the lower or rectal segment of gut, ligate its vessels which are easily seen. Continue the incisions in the meson downwards on each side of the rectum, stripping the peritoneum off the meso-rectum. Divide the peritoneum anteriorly so as to separate the rectum from the uterus, or from the bladder, prostate, etc.

Step 4.—Find and ligate the inferior mesenteric artery just to the left of the promontory of the sacrum. With gauze wipe downwards all the fat and lymphatic tissue posterior to the rectum; this is rendered possible by the incision and reflection of the peritoneal surfaces of the meson. While wiping the fat downwards expose and ligate the middle sacral artery as high as possible. Continue the gauze dissection, laying bare the internal iliac vessels and the ureters. Find and ligate the middle hemorrhoidal arteries which arise, one on each side, from

* The above description has been taken, practically completely, from Monod and Vanverts' "Traité de Technique Operatoire."

the anterior divisions of the internal iliac arteries and run inward to the middle portion of the rectum.

Step 5.—If sufficient gut above the anus is healthy, complete the operation

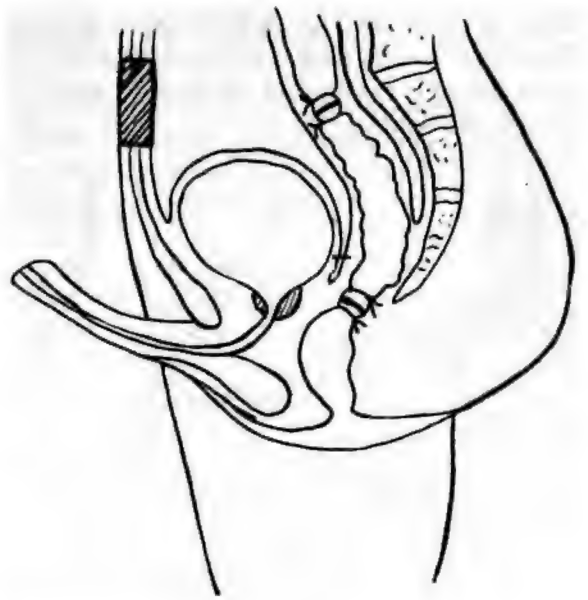
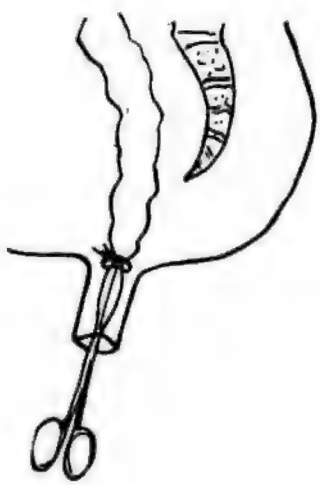


FIG. 607.



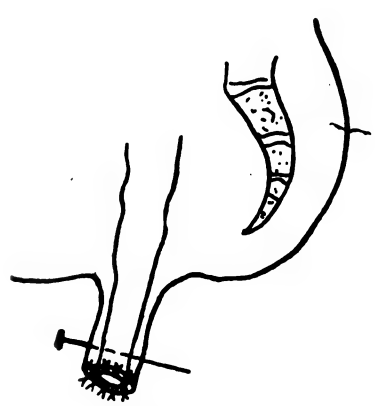


FIG. 608. FIG. 609.
FIGS. 607, 608 and 609. (*Weir, "Jour. Am. Med. Assoc."*)

by Weir's method. If restoration of the continuity of the intestinal canal is impossible or too dangerous, complete as in Quénu's operation.

R. F. Weir's Operation.—This operation is suitable in cases of cancer situated high up in the rectum.

Step 1.—Open the abdomen in the middle line or through the left rectus muscle.

Step 2.—Free the rectum from its connections to a point near the tip of the coccyx posteriorly and to the edge of the prostate anteriorly.

Step 3.—Divide the gut between two ligatures above the tumor (Fig. 607).

Step 4.—By means of forceps passed up through the anus seize the upper end to the lower segment of gut and pull it out through the anus, thus inverting the gut. Cut away the tumor.

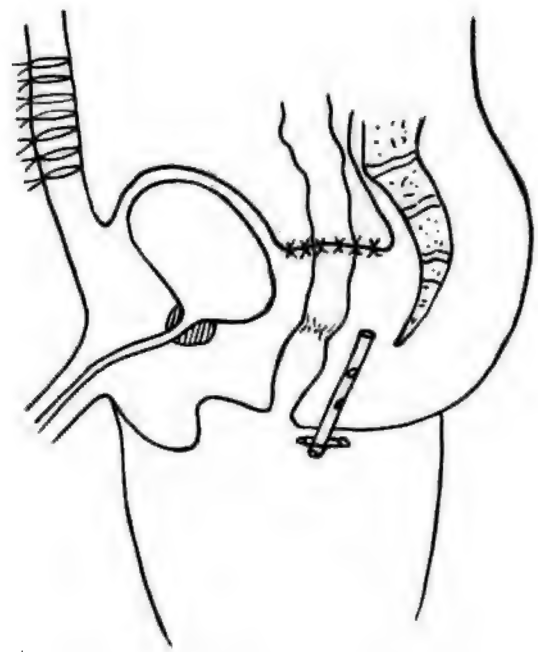


FIG. 610—(*Weir, "Jour. Am. Med. Assoc."*)

Step 5.—Pull the distal end of the proximal segment through the inverted lower segment. The serous surfaces of the two segments lie in apposition. Unite the two segments by means of Maunsell's method of suturing (Figs. 608 and 609).

Step 6.—Reduce the prolapsed gut. Suture the pelvic peritoneum divided when freeing the rectum from its connections (Fig. 610). This suture shuts off the general peritoneal cavity from the deep portion of the pelvis. Drain the lower portion of the pelvis through an incision made behind the anus (Fig. 610).

Maunsell and Trendelenburg have performed a very similar operation, but drain the deep pelvis with gauze brought out through the abdominal wound.

Miles Operation (Brit. J. Surg., Oct., 1914).—*Step* 1.—Place the patient in the high Trendelenburg position. Make an incision just to the left of the linea alba from the symphysis pubis to or beyond the umbilicus. Examine the liver for

metastases. Examine the pelvic mesocolon for nodules or plaques of growth, if such are present or if the bladder or vagina are involved in the disease the case is inoperable. It is important to have the pelvis cleared of all the small intestines and if it is impossible to keep them out of the way in the upper abdomen Miles does not hesitate to pull them out of the wound and let them hang down outside the abdomen protected by an abdominal swab wrung out of warm salt solution.

Step 2.—Draw the pelvic colon through the wound, if necessary, mobilizing it by incising the *outer* side of its mesocolon. This mobilization exposes the colonic vessels and permits of the proximal segment of colon being subsequently used for colostomy without undue tension. Choose a point on the bowel between the anastomotic loops of the first and second sigmoidal branches of the inferior mesenteric artery and apply to the bowel a powerful crushing forceps for about two minutes. Miles clamp uses a blade 1 inch wide. Remove the clamp and pass a stout thread through the meson at each extremity of the crushed area and tie firmly (Fig. 611). Divide the bowel between the ligatures and also a portion of the mesocolon which has also been crushed. Invaginate the ligated ends of the bowel by means of purse-string sutures.

FIG. 611.—Showing the crushed area of the bowel after removal of the clamp.

A ligature is passed through the mesocolon close to the bowel on either side of the crushed area, and tied firmly. The interrupted line indicates the incision to be made through the crushed bowel and adjacent portion of the mesocolon. (Illustration taken from Mr. Ernest Miles' paper in the *British Journal of Surgery*, October, 1914.)

Step 3.—Make an incision through the peritoneum on the outer aspect of the pelvic mesocolon along its parietal border at the level of the left sacro-iliac synchondrosis. Note and avoid the left ureter as it crosses the common iliac artery (Fig. 612). This is important because the ureter is parallel and close to the inferior mesenteric vessels and might easily be ligated with them. Ligate the inferior mesenteric artery immediately below the origin first sigmoid branch. If the first and second sigmoid arteries arise by a common trunk do not ligate the trunk but tie the first sigmoid below the trunk and the second when the mesentery is divided. Divide the remainder of the pelvic mesocolon, the inferior mesenteric vessels as they lie in its parietal border being also divided below the point of ligature. Drop the proximal end of the colon temporarily into the abdominal cavity.

Step 4.—Beginning at the point where the pelvic mesocolon has been cut across, make an incision on either side of the attachment of the lower portion of the pelvic mesocolon at a distance of about 1 inch from it. Carry these incisions downwards parallel to the mesocolon to the level of the peritoneal reflexion in the pelvis. These incisions are in the posterior parietal peritoneum

on each side of the meson and 1 inch from it. This gives access to lymphatics which extend under the peritoneum to each side of the meson. Pull

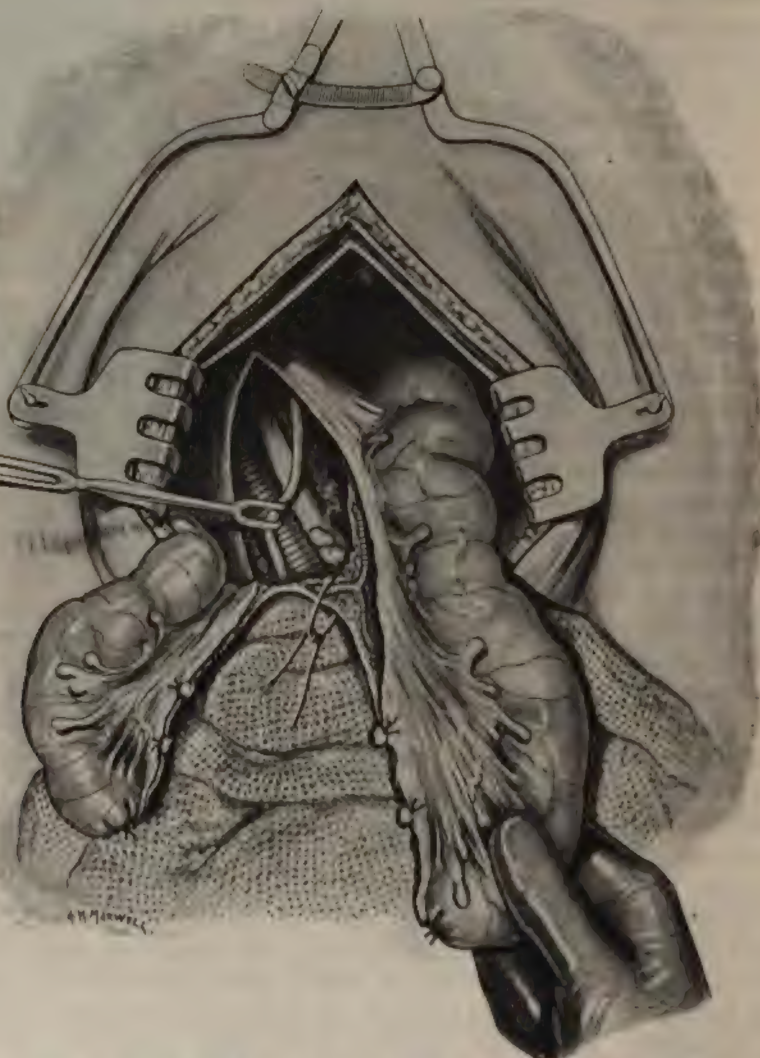


FIG. 612.—Showing complete division of the pelvic mesocolon and ligature of the inferior mesenteric artery at the seat of election.

The portion of the bowel on the left-hand side is that from which the colostomy is eventually made. The incision in the peritoneum, carried forward on the left side, exposes the left ureter as it crosses the left common iliac vessels. The ureter is drawn aside while the ligature is placed around the inferior mesenteric vessels. (Illustration taken from Mr. Ernest Miles' paper in the *British Journal of Surgery*, October, 1914.)

the distal segment of colon forwards and open the connective-tissue space in front of the concavity of the sacrum. By finger and gauze dissection, from above downwards, detach the rectum (ensheathed in the fascia propria recti) along

with its meson, blood-vessels and lymphatic glands from the ligamentous structures in front of the sacrum (Fig. 613).

Carry this separation down to the level of the sacro-coccygeal articulation which may be recognized by the firm attachment of the fascia propria recti to the end of the sacrum. Do *not* injure the median sacral veins.

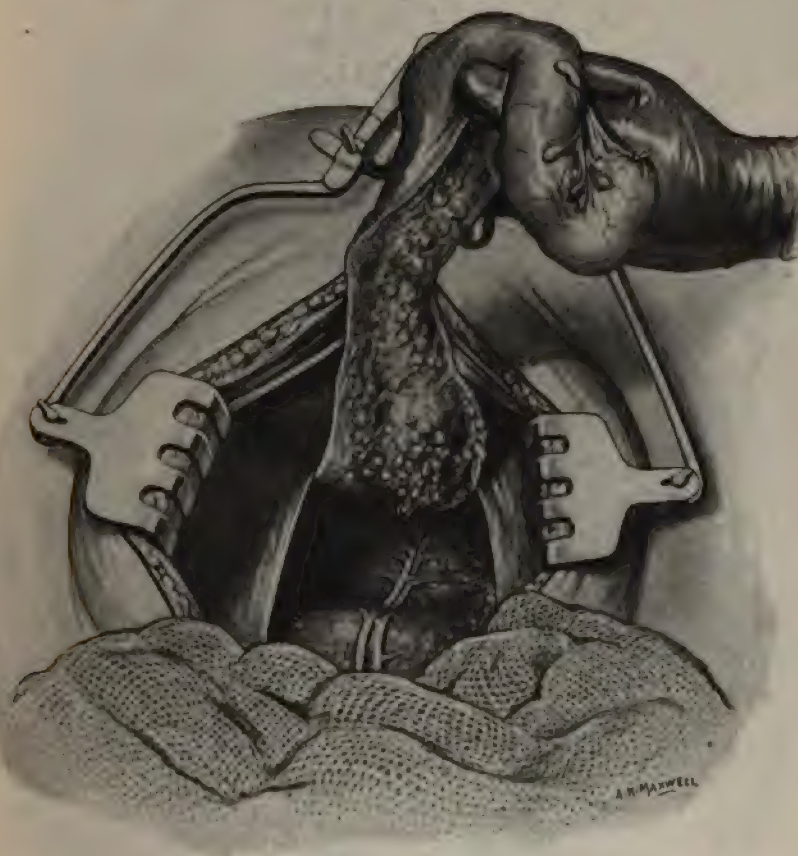


FIG. 613.—Showing the rectum and the retrorectal tissues separate from the hollow of the sacrum as far as the sacrococcygeal articulation.

After ligature of the inferior mesenteric vessels, the remains of the pelvic mesocolon are divided below the ligature, and the incisions in the pelvic peritoneum are carried forwards on either side along the lateral wall of the pelvis. The cellular space in front of the sacrum is opened up as far as the coccyx. (Illustration taken from Mr. Ernest Miles' paper in the *British Journal of Surgery*, October, 1914.)

Step 5.—Bring the two peritoneal incisions forward around the rectum to meet behind the base of the bladder in the male or the upper portion of the vagina in the female. Look out for the ureters which are adherent to the parietal peritoneum as they skirt the lateral wall of the pelvis on their way to the bladder.

Bluntly separate the anterior wall of the rectum from the bladder and

seminal vesicles as far as the upper border of the prostate, in the male looking out for and avoiding the vasa deferentia, and from the vagina in the female.

Step 6.—The lateral ligaments of the rectum are two strong bands of con-

FIG. 614.—Showing the separation of the anterior connections of the rectum as far as the upper border of the prostate, and division of the lateral ligaments.

The lateral incisions in the peritoneum have been extended on either side so as to meet in front behind the base of the bladder. The lateral ligaments have been defined as far as the upper surface of the levator ani on either side. These ligaments are then completely divided with scissors, the ureter on the left side having been drawn aside. (Illustration taken from Mr. Ernest Miles' paper in the *British Journal of Surgery*, October, 1914.)

nective tissue, each about 1½ or 2 inches deep, extending from the sides of the rectum forwards and outwards towards the base of the bladder (Fig. 614). Separate the rectum from its lateral attachments. On the left side never lose

sight of the ureter as it lies close to the rectum and is easily injured. On the right the ureter is more remote and ought to be left undisturbed in its attachment to the parietal peritoneum.

Divide the lateral ligaments *completely*. Failure in completeness of this section renders the perineal portion of the operation difficult. When dividing

FIG. 615.—Showing method of restoring the pelvic floor of the male.

A flap of peritoneum has been dissected up from the bladder and drawn backwards until it meets the cut edge of the pelvic mesocolon, to which it is sutured. On the right side the distal portion of the pelvic colon can be seen lying in the pelvic cavity below the new pelvic floor. (Illustration taken from Mr. Ernest Miles' paper in the *British Journal of Surgery*, October, 1914.)

the left lateral ligament do not forget the ureter. The middle hemorrhoidal arteries lie in the lateral ligaments but are small and rarely require ligation.

Miles remarks that these are the only branches of the internal iliac arteries divided during the abdominal part of the operation and hence there is no use in preliminary ligation of the internal iliacs as is sometimes advised.

Step 7.—The rectum having been freed in all directions, anteriorly as far as the upper border of the prostate or half way down the posterior vaginal wall,

posteriorly as far as the sacro-coccygeal articulation, and laterally down to the levatores ani, push it down into the cavity of the pelvis. The peritoneum on each side of the pelvic mesocolon has been widely excised (this incision is fundamentally important to prevent recurrence); therefore a large gap remains which must be closed. Dissect the peritoneum freely up from the lateral walls of the pelvis (avoiding injury to the ureters) until the posterior margins can be brought together in front of the promontory of the sacrum, without undue tension, and sutured to the stump of the pelvic mesocolon where the inferior mesenteric

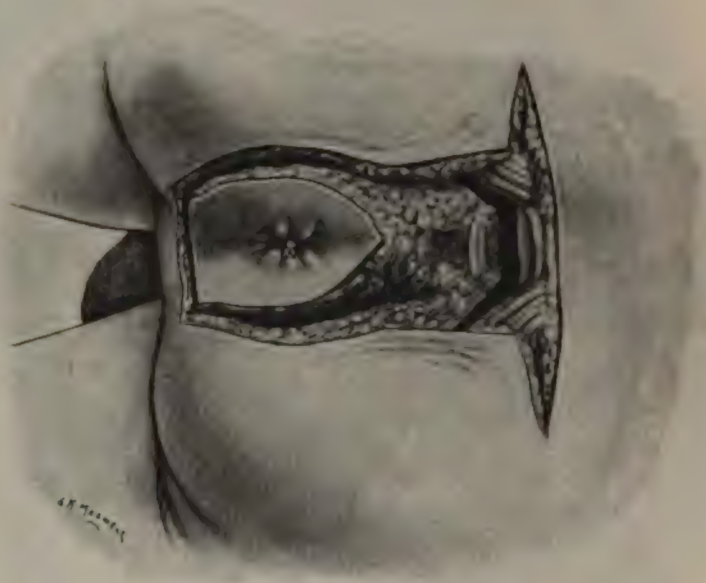


FIG. 616.—Showing the reflection of the skin flaps and opening of the sacrococcygeal joint. When the surface incisions around the anus are deepened, as much as possible of the ischiorectal fat is included. (Illustration taken from Mr. Ernest Miles' paper in the *British Journal of Surgery*, October, 1914.)

vessels have been tied. A large pear-shaped gap still remains. In the male dissect up a flap of peritonenm from the bladder, lay it across the gap and suture. In the female dissect up the innermost layers of the broad ligaments and use the flaps to fill the defect (Fig. 615). It is tempting to use the uterus to cover the gap but Miles found that menstrual troubles resulted. Omental grafts may be required to supplement the peritoneal flaps.

Step 8.—Pull the proximal segment of colon through a small incision about 1 inch internal to the left anterior superior iliac spine and establish an artificial anus (it is well not to open the new anus for some time).

Step 9.—Attend to the toilet of the peritoneum. Introduce two or three pints of warm saline solution into the abdomen. Close the wound. Apply dressings.

Step 10.—Place the patient in the right dorsal semiprone position. Close the anus by a purse-string suture. Make the incision shown in Fig. 616. Open the sacro-coccygeal articulation and remove the coccyx. Make a small transverse incision into the dense connective tissue immediately below the sacrum, where the attachment of the fascia propria recti can readily be detached from the front of the lowermost piece of the sacrum. Thrust the index finger into this and so into the space containing the isolated bowel. Divide the coccygei muscles transversely on each side, extending the cuts outwards as far

FIG. 617.—Showing the pelvic colon and the isolated upper part of the rectum withdrawn from the cavity of the pelvis.

If the isolation of the rectum has been efficiently carried out anteriorly, posteriorly, and laterally, the bowel can be readily withdrawn, in the manner shown, and the base of the bladder, the vesiculæ seminales, with the vasa deferentia and the prostate gland, are clearly exposed to view. The levatores ani are then divided close to their origin from the pelvic wall. (Illustration taken from Mr. Ernest Miles' paper in the *British Journal of Surgery*, October, 1914.)

as the sacro-sciatic ligaments (Fig. 617). Pull the bowel out through this wound. If in the earlier stages of the operation the anterior connections of the rectum have been separated down to the prostate, the base of the bladder, the vesiculæ seminales, the vasa deferentia and the upper part of the prostate, come into view. In the female, the uterus and upper half of the vagina are exposed. Pull upon the bowel and thus put the levators ani on the stretch. Divide them close to the lateral wall of the pelvis. If these muscles do not come into view on traction being made it is because the lateral ligaments of the rectum

have not been sufficiently divided in step 6. Until these ligaments have been completely divided, delivery of the bowel is difficult and the levatores cannot be divided.

If the growth is situated on the anterior wall of the ampulla, Miles always removes the prostatic capsule with the rectum.

Dissect the anal canal from the perineum avoiding injuring the membraneous urethra.

Step 11.—Pack the huge cavity with strips of gauze to support the pelvic floor which is formed only of peritoneum, but place a sheet of protective or rubber dam between the gauze and the walls of the cavity to prevent adhesion. Adhesion of the gauze to the peritoneum has caused serious trouble. Close most of the wound with sutures. Apply dressings.

Tuttle's Operation.—("Amer. Journ. Surg.," June, 1910.) Prepare the patient during several days by diet, purges, irrigations, etc. Immediately before operation irrigate the rectum with a 3 per cent. solution of formalin, wiping this out and then injecting two or three ounces of pure peroxide of hydrogen up into the rectum and above the tumor if possible.

Step 1.—Put the patient in the Trendelenburg position. Freely open the abdomen by a longitudinal incision just outside the left rectus muscle. Examine for adhesions, metastasis, etc.

Step 2.—Treatment of meso-sigmoid. Select "a point on the sigmoid two inches further above the tumor than the latter is above the anus." Make a small incision in the peritoneal layer of the meso-sigmoid, one-half inch from the margin of the gut; introduce through the incision a thin spatula-like director and on this as a guide incise the peritoneum parallel with the gut down to the tumor. Turn the gut over and repeat the process on the other side of the meso-sigmoid. Strip the peritoneum back on both sides of the meson to its origin on the posterior abdominal wall. Division of the peritoneum as described permits the gut to be pulled further out of the wound and facilitates tying the blood-vessels and removing the glands.

Step 3.—The gut being pulled upwards through the wound, begin near the origin of the visible vessels to brush all fat and glands from them by gauze dissection, towards the intestine until the lower sigmoidal artery is found and traced to its origin in the superior hemorrhoidal. Doubly tie and divide the superior hemorrhoidal artery just above the origin of the lower sigmoidal, which point is usually just below the promontory of the sacrum and in the angle of the iliac vessels.

A glance at Fig. 618 shows that if the ligation is made as directed (XX') the anastomosis between the colonic and hemorrhoidal vessels is ample to keep up the circulation in the latter. An extra amount of mobilization may be obtained by double ligation and division of another anastomotic trunk at YY' without interference with the rectal nutrition.

Step 4.—Split the deep fascia behind the lower stump of the ligated vessels and peel the rectum, fat and glands out of the sacral cavity down to the tip of

the coccyx posteriorly and to the upper surface of the levatores ani on the sides. Pack the cavity with hot moist gauze to control oozing.

Step 5.—Carry the peritoneal incision "across the gut one inch above the tumor and through the cul-de-sac between the gut and the bladder or the uterus as the case may be."

Separate the gut from the anterior organs by blunt dissection as far down as possible without too great traumatism, usually as far as the prostate at least.

Step 6.—Remove the gauze from the sacral cavity. Examine the sigmoid and on it choose the lowest portion (well above the tumor) where the nutrition is above reproach. Carry this part of the sigmoid down to the tip of the coccyx to measure whether it can be brought out of the anus without tension. If it cannot, study whether it is the blood-vessels or the peritoneal covering of the meso-sigmoid which holds it. If the peritoneum, then increase the incision made in Step 2; if the vessels, feel which one is at fault and divide it between two ligatures (Fig. 618, YY′) in such a manner as not to interfere with anastomosis.

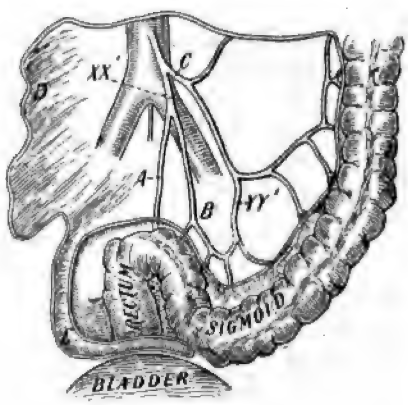


FIG. 618.—Mobilization of sigmoid by division of vessels.

Step 7.—*Method A.*—The tumor is of moderate size and is three inches or more from the anus. Tie a narrow tape with long ends around the gut just above the tumor. Have an assistant dilate the anus and pass through it a long dressing forceps to a point just below the tumor. Protect the abdomen with pads. Make the points of the forceps perforate the gut just below the tumor; seize the ends of the tape with the forceps and pull them into the gut and out through the anus. By pulling on the tapes and pushing the tumor downwards, the tumor is invaginated into the lower segment of gut and out through the anus dragging after it the lower segment of mobilized sigmoid to the desired extent. Replace all reflected flaps of peritoneum and repair all peritoneal wounds with sutures until the floor of the pelvis and the meso-sigmoid are entirely restored. Close the abdomen. Put the patient in the lithotomy position. Cut through the rectum or surrounding tube (intussuscipiens) all around, catch the edges with forceps. Through this circular wound note the intussuscepting sigmoid (intussusceptum) and find the lowest point in it where the circulation is good (prove that the circulation is good by puncturing with a needle) and yet which is high enough above the tumor. Suture this portion of sigmoid to the wall of the everted rectum. Cut away the gut below the line of suture and stitch the mucous membrane of the sigmoid to that of the rectum. Pass a large rubber tube into the rectum. With four sutures passed through the margin of the gut and the skin outside the anus prevent retraction inwards of the line of suture until union has taken place. Mayo uses safety pins

instead of sutures. Drainage is secured by a tube or cigarette drain introduced into the hollow of the sacrum through a cut made alongside the coccyx.

Method B.—The tumor is high up and too large to be evaginated through the anus. Have the assistant make an incision alongside the coccyx and through this pull out the tapes and with them the sigmoid. Repair the peritoneum and close the abdomen. Excise the tumor through the parasacral incision, enlarging this if necessary. Unite the ends of the gut by circular sutures or evaginate them through the anus and treat them after the manner described in Weir's operation, page 499.

Balfour's Operation.—("Annals of Surg.," Feb., 1910.) Suitable for tumors near the junction of the rectum and sigmoid.

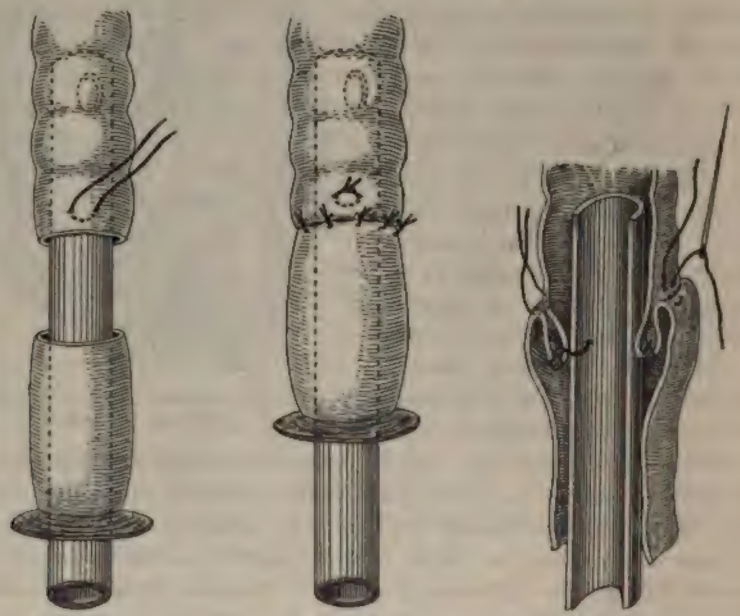


FIG. 619. FIG. 620. FIG. 621.

FIGS. 619, 620 AND 621.—Balfour's operation.

Step 1.—Place the patient in the high Trendelenburg position. Excise the tumor in the usual manner, through an abdominal incision.

Step 2.—Provide a rubber tube about 3/4 inch in diameter similar in stiffness to those used for colonic lavage. The tube should have a lateral eye near its end to permit the escape of gas should the end become obstructed. Pass the tube from the abdomen through the lower segment of gut so as to protrude through the anus. Pass the "eyed" end of the tube into the proximal segment of sigmoid for about 3 inches having previously prevented accidental extrusion of fæcal matter by the application of a guarded clamp placed sufficiently high above the line of section. One-half inch above the cut end of the sigmoid fix the tube to the intestine by a transverse stitch of catgut (Fig. 619).

Step 3.—Have an assistant pull upon the tube projecting from the anus until the cut ends of the proximal and distal segments of intestine are in apposition. Unite the upper to the lower segment of intestine by carefully applied, interrupted, through-and-through sutures of chromicized catgut. Be careful to coapt the mucous membranes (Fig. 620).

Step 4.—Have the assistant once more pull upon the protruding tube so as to produce an invagination of the proximal for about ½ inch into the distal segment of gut. Assist this invagination by steadying the lower segment of the intestine with a few forceps. Insert sero-muscular sutures around the invagination to prevent the withdrawal of the intussusceptum (Fig. 621). (Occasionally it has been impossible to insert the second row of sutures and yet good results have been obtained.)

Step 5.—Repair the peritoneal wound behind the anastomosis by sliding the peritoneum and suturing it. Pull the omentum down over the site of anastomosis and, if necessary, secure it there by a catgut suture.

Step 6.—Close the abdomen after providing for drainage.

The rubber rectal tube remains *in situ* until the catgut suture is absorbed (about six days). Do not remove the abdominal drain for one week because a temporary fæcal fistula sometimes occurs.

Rotter ("Handbuch der praktischen Chirurgie") writes: "The tendency of the French to make a permanent iliac anus in every case is not approved in Germany. Whenever practicable, we endeavor to preserve the sphincter ani, and consequently continence. This, as a rule, can be attained. The danger of infection is very slight, as the gut is only opened at the end of the operation. If union of the divided ends of the gut is impossible owing to the shortness of the upper segment, we prefer to make a sacral rather than an iliac anus."

German surgeons, as a rule, make use of an abdomino-dorsal instead of an abdomino-perineal operation. By the sacral (dorsal) route they expose and free the rectum as far as conditions permit, and then, if they meet with difficulties, open the abdomen, mobilize the gut to the necessary extent, close the abdominal wound, and pull the gut (rectum and, if necessary, sigmoid) out of the sacral wound, when the neoplasm is excised and the divided ends of gut united by circular enterorrhaphy or by the invagination method.

W. E. Miles has had a large experience in both the perineal and sacral operations and found the ultimate results to be atrocious; in fact there was recurrence in 55 out of 58 patients. He operates by the combined method (p. 500) removing nearly the whole of the pelvic colon, the whole of the corresponding meso-colon, the whole of the levatores ani, the whole of the rectum and anus and ischio-rectal tissues, making a permanent inguinal colostomy. His patients have practically complete sphincteric control of the abdominal anus which is neither unsightly, uncleanly nor a source of discomfort. He writes: "The operation is a severe one. I do not think that it should be performed on those over 60 years of age; of 10 such cases all died. With regard to the remainder, of whom there were 36, 8 died from the effects of the operation, 4 have had

recurrence, 2 died of intercurrent disease, while 22 are to-day alive and well after periods varying from six months to six years" ("Brit. Med. Journ.," Jan. 25, 1913).

Handley ("Universal Med. Record," 1912, 385) has improved on the method of performing the combined operation as follows: When the gut has been divided above the disease (Step 4, Quénu's operation, page 463), completely close the end of the bowel which is to form the future artificial anus and bring it out through a stab incision just within the left anterior superior spine (possibly better control may be obtained by making the incision through the left rectus muscle). At the end of the operation make a small stab into the blind protruding end of the bowel, introduce a rubber catheter and tie it in with a purse-string suture. Use the catheter for the exhibition of salt solution by the drop method or when the solution is not being given permit flatus to escape by it. About the fifth day excise the protruding bowel and form the artificial anus. Handley advises the use of anti-streptococcic serum and of mixed staphylococcic vaccine as a preliminary to operation.

CHAPTER XXXVII

HÆMORRHOIDS AND FISTULÆ

External Hæmorrhoids.—External hæmorrhoids are practically never operated on except when inflamed. It is well to snip away with scissors any tags of skin around the anus at the same time as the pile is attacked; this to avoid subsequent trouble.

Hold the inflamed pile between the finger and thumb of the left hand. Transfix the base of the pile with a knife in the direction of the radiating anal folds. Cut outwards between the finger and thumb, thus splitting the pile. By squeezing or with a forceps or curette evacuate the contained blood-clot. Remove with scissors redundant tissues. Sutures are unnecessary. Apply a little simple ointment and a pad of cotton. The after-treatment consists in keeping the bowels open, occasional washing of the parts, reapplication of ointment and pad and the exercise of moderate patience for a few days.

Internal Hæmorrhoids.—*Preparatory Treatment.*—Evacuate the bowels thoroughly. Allingham advised giving two pills each containing blue mass gr. j. with gr. v. of pil. colocynth. et hyoscyami thirty-six hours before operation and using an enema of soap and water a few hours prior to operating. This method is as good as any.

Methods of Operating.—I. *Excision.*—(*a*) Place in lithotomy position. Dilate anus completely with thumbs or bivalve speculum. Catch each pile to be removed in a forceps. The removal of three pile masses is all that is usually necessary; if more are removed stricture may result. Cut away the lowermost pile with scissors. Pick up and ligate all bleeding vessels. Suture the wound. The operation is easy *on paper*, but it is not easy to pick up the vessels and to apply the suture neatly. Before it was customary to dilate the anus completely, excision was dangerous because of concealed hæmorrhage into the rectum. This danger no longer exists.

(*b*) Thelwell Thomas' method is a type of operation devised by many surgeons.

Lithotomy position: Completely dilate anus.* Catch the pile masses in forceps. Grasp the base of one pile in a forceps having a blade about 2½ inches long and not too thick. Be careful not to include any of the skin in the forceps. Cut away the pile about ⅜ inch distal to the forceps. Arm a stout catgut suture about ten inches long with a rounded needle at each end. Pass the suture through the upper end of the stump distal to the clamp and tie firmly. Do not cut the suture, but pass the needles one from one side, the other

* Many surgeons avoid dilating the anus claiming that recovery is more perfect than where it is dilated.

from the other side through the stump about ⅜ inch away from the first stitch and tie firmly over the stump. Repeat the stitch (Fig. 622) as often as necessary to completely suture the stump. Remove the clamp. There may be a little oozing from the mucous membrane where crushed by the clamp. Treat the other tumors in the same way. It is usually only necessary to remove three pile masses. If more tumors must be removed and stricture is feared, Thomas advises to apply the clamp to one or more of the tumors transversely to the axis of the gut and suture in the same direction, the resulting scar being transverse also.

After-treatment.—On completion of the operation introduce two suppositories, one containing 3 grs. of iodoform, the other ½ gr. of morphine. Apply a pad of gauze or cotton and some simple ointment to the anus.

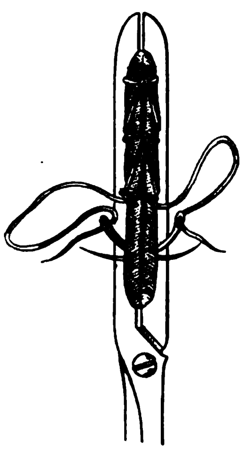


FIG. 622.—Excision of piles.

On the fifth day give a laxative. After the bowels move, introduce an iodoform suppository. The author finds that there is little use in keeping the bowels locked up; if they show a tendency to move it is satisfactory to give an enema of a few ounces of warmed sweet oil. A favorite dressing with some surgeons is to introduce into the rectum a tube surrounded by gauze: the tube permits the exit of gas; the gauze is supposed to keep the wound clean and prevent bleeding. This dressing ought to be reserved for personal enemies and malefactors as it does no good and can cause much suffering. After excision the patient is generally well by about the seventh day.

II. *Ligation.*—(*a*) Lithotomy position: Dilate the anus completely. Catch the piles to be removed with forceps. Pull the lowermost pile downwards by the forceps attached to it. Note the white line at the junction of the skin and mucous membrane; beginning at this line immediately below the pile, with scissors separate the pile from the subjacent submucous and muscular tissues on which it rests. Continue the separation upwards until the pile remains hanging by a small pedicle of vessels and mucous membrane. This is possible and safe because all the vessels enter or leave the tumor above, immediately under the mucous membrane. Tie the pedicle tightly with a strong but not thick silk ligature. Cut away the tumor distal to the ligature. Before applying the ligature it may be convenient to crush a groove in the pedicle with a strong forceps. This permits the use of a lighter ligature. Treat the other piles in the same manner.

(*b*) Modified ligation: Separate the pile as for ligation. Divide the mucous membrane above the pedicle so that the pedicle comes to consist of vessels alone. Ligate the vessels with catgut. Suture the mucosa. This operation is practically an excision.

III. *Clamp and Cautery Operation.*—Many clamps have been devised. The simplest are Langenbeck's, Smith's or Gant's. Some have ivory on the

under side to keep the heat from burning the skin. A piece of asbestos paper placed between the clamp and the skin is a cheap and effective substitute for the ivory.

Lithotomy position: Dilate the anus completely. Seize with forceps each pile to be removed. (The removal of three pile masses usually suffices.) Seize the base of the lowermost pile in a clamp. Arrange asbestos paper between the clamp and the skin. Burn away the protruding pile completely with the cautery. Some surgeons cut away the pile, leaving a stump ¾ inch long protruding from the clamp and cauterize this stump. Paquelin's cautery is useful in this operation; so is an electro-cautery, but both these instruments are fairly expensive and often out of order. Ordinary soldering irons are cheap, easily heated in a lamp and are always reliable. They should be heated to a dull red color and allowed to cool slightly before being used.

IV. *Excision of the Pile-bearing Area.*—(*a*) *Whitehead's operation*, sometimes called the American operation.—Lithotomy position: Dilate anus completely. Make an incision all around the anus at the junction of the skin and mucous membrane. Separate the mucous membrane by blunt and occasional sharp dissection from the external and internal sphincter. Attend to hæmostasis. The whole pile-bearing area (there are exceptions to this rule) now hangs separated from the subjacent tissues. Divide the mucous membrane transversely above the pile area in successive stages. As each segment of mucosa is divided bring its free margin down and suture it to the corresponding edge of skin. This is much easier than cutting off the whole loosened segment of gut at once.

(*b*) *Vercesco's Method* (Potarca, "Rev. de Chir.," May, 1902).—Prepare a champagne cork by providing its narrow end with a handle (a loop of stout wire is satisfactory). Have a number of fine tacks ready.

Lithotomy position: Fully dilate anus. Reduce the piles. Pass the champagne cork, thick end first, into the bowel. Make a short incision through the muco-cutaneous junction. Tack the separated mucosa to the cork. Repeat this until the incision runs completely round the anus and the whole circumference of the mucosa is tacked to the cork. By means of the handle on the cork pull the cork and with it the gut downwards and separate, as in Whitehead's operation, the pile area from the subjacent structures. Attend to hæmostasis. Suture the free edge of skin to the raw surface of the mucosa (on the cork) all around the anus. With a knife divide the mucous membrane immediately distal to the line of suture and remove the cork and with it the pile-bearing tissues. Instead of suturing as above one may make a short incision through the mucosa, suture it to the corresponding free edge of skin and repeat this alternate cutting and suturing until the operation is completed. The advantage of this method over the Whitehead's consists in the avoidance of soiling the deep wound with intestinal discharge during the operation.

Choice of Operation.—Excision of the pile-bearing area depends for success on healing by first intention. This does not always take place; if it does not, then healing must be by granulation and stricture results. Wetherill has seen cases where after perfect union was obtained the sensitiveness of the anus

was so obtunded that the normal impulses which precede and call for the act of defæcation were absent and a condition of persistent constipation was established. The same cause may lead to incontinence of gas and fæces. The other methods of operating all give good results. Each surgeon *knows* that the method he uses gives better results than any other. The author's preference is for the Thelwell Thomas operation.

Pruritus Ani.—In long-standing cases of pruritus where medical treatment has failed to give relief and where no evident removable cause for the itching can be found, a cure may be effected by one of two operations:

I. *Cauterization.*—Administer a general anesthetic. Thoroughly dilate the anus. Remove any tags of skin or small polypi which may present. Apply lightly the flat side of a Paquelin cautery, at a white heat, to every part of the affected anal skin. Only the superficial epithelium ought to be destroyed and on recovery there should be no scar formation.

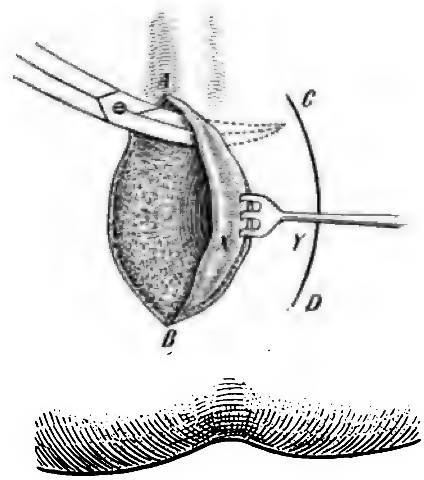


FIG. 623.—Operation for pruritus ani.

II. *Ball's Operation.*—Division of the terminal branches of the nerves supplying the affected skin.

Step 1.—The patient being in the lithotomy position, make the incision A B (Fig. 623) on one side of the anus and reflect the flap X, consisting of skin and subcutaneous tissue. The fibres of the external sphincter should be exposed and the dissection continued up to and beyond the muco-cutaneous junction. With scissors undermine for a short distance the skin to the outer side of the incision A B.

Step 2.—On the opposite side of the anus make the incision C D and reflect the flap Y as in Step 1. Be careful that the distance between A and C and between B and D is fully one inch.

Step 3.—With scissors, undermine the bridges of skin A C, B D. Attend to hæmostasis.

Step 4.—Replace the flaps X and Y and suture the wounds A B and C D. Apply dressings. Sensation gradually returns in the area of operation.

Lockhart-Mummery (Brit. Med. Jour., Aug. 21, 1915) very strongly endorses Ball's operation.

III. *Lynch's operation* (Med. Record, June 13, 1914) is almost identical with Ball's except that the incision is only about ½ inch in length, and from it the skin is undermined from the anterior raphé to the posterior commissure within a radius of 1½ inches from the anus. Bleeding is controlled by pressure and the wound is drained for twelve hours by a small piece of rubber tissue. As a rule no sutures are required and the wound is healed in about forty-eight hours.

FISTULA IN ANO

Anal fistulæ are the result of the breaking-down of inflammatory deposits beside the anus or lower rectum. They show no tendency to heal because of the absence of cleanliness and of rest, incident to their relation with the sphincter and the pelvic diaphragm.

1. *Complete fistulæ* have openings both in the skin and mucous membrane of the gut.

When the fistula consists of a comparatively straight tube leading from the skin to the gut its operative treatment is simple.

The Operation.—Prepare as for hæmorrhoid operation (see page 513). Place the patient in the lithotomy position or on his left side with the right thigh flexed and separated from the left.

Shave and cleanse the parts. Introduce a fine and fairly pliable grooved director into the opening in the skin and pass it through the fistula into the gut. Pass the forefinger of the left hand through the anus and hook it over the point of the director. Bring the point of the director with the finger out through the anus. Pass a probe-pointed bistoury along the grooved director and cut through all the tissues covering it. The fistulous canal is now a gutter—open throughout its whole course. With a sharp spoon scrape away the granulation tissue lining the fistulous track. Wash the wound with an antiseptic solution and rub in a little iodoform powder. Loosely pack the wound with iodoform gauze to compel healing from the bottom up. Apply dressings. Keep the bowels locked up for four days and then open them with a dose of castor oil. The wound requires frequent dressing after the bowels are allowed to move. The above description applies to a very simple case; where the openings are multiple the operation becomes more severe.

Operation where the Fistula has Several Internal and External Openings.—Pass a director through the principal fistulous track and divide as described above. From this main incision make secondary incisions so as to open up the other fistulous tracks and openings. Thus all the internal openings are joined together and all the external openings are joined together. *It is important to make but one cut through the sphincter and that at right angles to the muscular fibres.* This is to avoid dangers of subsequent incontinence of fæces. When the mucous membrane of the gut is much undermined by the disease, gently scrape away the infected tissue and if the mucous membrane covering it is thin, incise or excise the thin portion, if thick leave it alone.

Scrape away diseased granulation tissue, wash the wound, rub in iodoform powder, pack loosely with iodoform gauze and dress.

If the packing of gauze plugs the anus so that the passage of flatus is interfered with, it is wise to introduce a small rubber tube through the dressings and the anus so that gases may escape at any time. Esmarch.

The great objection to the usual operations for extensive fistula in ano is that the healing process being slow much granulation tissue is formed and develops into fibrous tissue; thus when healing is complete the sphincter, which

retracted on division, becomes united by the interposition of a larger or smaller mass of scar tissue and so incontinence, partial or complete, results. To avoid dangers of incontinence the following operation may be employed:

1. Pass a probe or director through the fistula. Guided by the probe freely incise the fistulous tract but do *not* divide the sphincter. The whole tract must be freely opened by division of the mucosa, etc., above the anus and of the skin external to the anus, but the anus itself and the sphincters are left intact. Pack the whole wound. If everything goes well the whole fistulous tract will heal except near the sphincter where a small sinus will be left. This small residual sinus or fistula is easily cured by dividing the sphincter which heals so quickly that no mass of scar tissue forms to interfere with its efficiency.

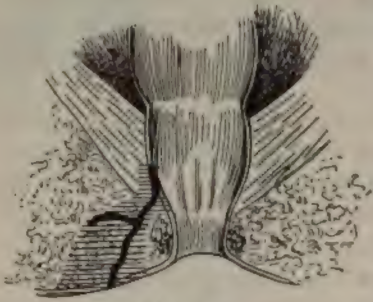


FIG. 624.

Elting ("Trans. Am. Surg. Assoc.," 1912) thinks that practically all anal fistulæ communicate with the intestine whether the point of communication be discovered or not, and that if this communication be destroyed the fistulæ will recover under almost any or no treatment.

Elting's Method.—Demonstrate, if possible, the inner opening of the fistula. Dilate the anus. Beginning at the mucocutaneous junction excise the mucous membrane, exactly as in the Whitehead operation, to a point above the fistulous orifice or, if such is not seen, up to the white line which shows where the levatores ani join the gut. Treat the wound as in the Whitehead operation. Curette the fistulous tracts and drain them, making stab wounds for drainage if necessary.

2. *Blind external fistulæ* have external but no internal openings. If the fistula is shallow and recent, one may enlarge the external opening, scrape away diseased granulation tissue and pack the resulting wound with iodoform gauze to encourage healing from the bottom up. Injection of the fistula with Beck's bismuth paste is often recommended. Rest may be secured by dilating the sphincter and so temporarily paralyzing it. This mild treatment is not often indicated.

The Operation.—After preparing the patient as already described, introduce the fine-grooved director into the fistula. Pass the index finger of the left hand into the rectum. With the director and finger find the point where the fistula most nearly reaches the gut. Forcibly bore or push the director through the intervening structures into the gut, protecting the latter with the finger. The rest of the operation is the same as for complete fistula.

3. *Blind internal fistulæ* have internal but no external openings.

The Operation.—The patient having been properly prepared as already described, introduce a suitable speculum (generally a bivalve speculum) into the gut and find the opening of the fistula. Through the opening pass a probe outwards towards the skin. Using the point of the probe as a guide cut through

the skin and convert the blind internal into a complete fistula. The rest of the operation is the same as that for a complete fistula.

4. *Excision of Fistula.*—Incise the fistula (complete or incomplete) as already described. With forceps, scalpel and scissors remove, if possible en masse, *all* the sclerosed diseased tissues surrounding the fistula. Attend to hæmostasis. With sutures close the whole wound. This is best done by suturing in layers with a continuous suture of fine catgut. The first series of sutures should be confined to the deep wound and not touch either the mucosa or the skin; the two latter structures should be closed by separate superficial sutures. If the sutures closing the deep wound pass through the mucous membrane or skin, they are liable to conduct infection into the deep structures.

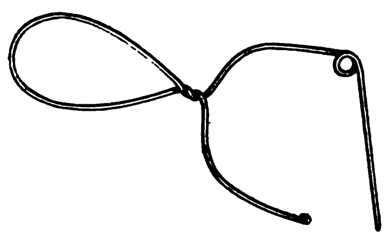


FIG. 625.—Thrailkill's probe.

Thrailkill excises fistulæ as follows: Pass the probe of the "safety-pin spring probe" through the fistula into the rectum; catch the end of the probe on to its hook (Fig. 625). Make an incision through the anal mucosa and the sphincter down to but not into the fistula. By taking hold of the handle of the instrument, the fistulous tract and wall can be firmly held while the diseased tissue, threaded on the probe, is dissected out in one piece.

Kenneth Mackenzie's Operation.—("Trans. Am. Surg. Assoc.," 1911.)

"1. The patient is prepared in the most careful way as for any major surgical operation on these parts.

"2. The sphincter is completely dilated.

"3. The internal orifice of the fistula is minutely examined and with a proper instrument is very cautiously dilated. After dilatation the mucosa is uplifted and pared with curved scissors in the direction of the long axis of the bowel, and with a small knife or fine scissors the circumference of the muscular layer is then trimmed and vivified. If need be, the opening may be incised or split in the direction of the circumference of the sphincter. After this has been done a few interrupted sutures of iodized catgut are introduced in the muscular layer at right angles with the sphincter, tied and divided. The mucous membrane is then sutured with interrupted chromic catgut or silk sutures, properly spaced. if more than one orifice exists, of course the same procedure is followed.

"4. A flap is made on the side involved, beginning by making a small semilunar incision just beyond the border of the external sphincter, dividing the parts down to the fistulous tract, the latter being divided flush at its point of emergence from the bowel (Fig. 626). The incision is extended from both ends of the first incision outward and made large and deep enough to include, if possible, under the eye all visible and accessible branching tracks. The exigencies of the case may require sometimes the lifting of one or other of the buttocks in its entirety. In one case, it was necessary to make a complete flap

and partial resection of both buttocks in order to reach the deepest and most distant branching tracks.

"5. The opposite side of the rectal opening is now attacked, and after all doubtful tissues have been removed the rectal walls are infolded once or twice over the line of suture within. The greatest care must be exercised in removing all doubtful tissues. If need be the cautery could be used for their complete destruction, or substituted entirely for the suture of these parts.

FIG. 626.

"6. The exposed flap is next attacked with knife or large pointed scissors, curved on the flat, and the original track, its branches and the entire fistulous zone including every branching track resected. Careful search will be made in the ischiorectal fossa and perirectal spaces for any concealed track.

7. The whole field is then carefully flushed with normal salt solution and, if need be, antisepticized and the fat layers sutured with buried catgut so as to close all dead spaces. In many cases the entire wound may be closed as in the case of breast amputation or a small drain may be left for twenty-four or forty-eight hours."

CHAPTER XXXVIII

ASCITES

Ascites.—Ascites may be due to many causes, notably to cirrhosis of the ver. In this disease interference with the portal circulation is supposed) cause the ascites by damming back the blood coming from the abdominal iscera to the liver. Rolleston and Turner argue that ascites does not occur rhen the blood pressure is presumably highest in the portal vein, *i.e.*, early in he disease; that ligation of the portal vein does not necessarily cause ascites; hat ascites is probably rather a result of a toxæmia than a mere mechanical esult of increased blood pressure. These observers think that any good btained by omentopexy is due (a) to a diminution of the blood flowing through the liver, permitting the liver cells to purify the blood passing through it more atisfactorily; (b) to an increase of the arterial supply of the liver, through ew-formed adhesions, this increased nutrition to the liver cells favoring their ompensatory hypertrophy.

Operations for ascites may be divided into two classes: I. Operations iming at the prevention of the effusion of the fluid. II. Operations aiming at the removal of the effused fluid.

I. **Morison-Talma Operation.** Omentopexy. Epiplopexy.

Long ago it was noted that after repeated removals of ascitic fluid by means f the trocar and cannula, recovery occasionally took place. This recovery as ascribed to the passage of some of the portal blood into the systemic circula- n through adhesions formed between the intra-abdominal viscera and the rietes. Talma and Rutherford Morison (the latter aided and abetted by mmond), each independently decided to open the abdomen and in a definite ion establish adhesions between the viscera and the parietes.

Step 1.—Open the abdomen near the middle line above the umbilicus. ourage all the ascitic fluid to escape. Mop out the fluid from the pelvis d the renal pouches with gauze.

Step 2.—With gauze rub the upper surface of the liver vigorously enough to e the formation of adhesions between it and the diaphragm. Do the e to the spleen.

Step 3.—*Method A.*—Pull the omentum into the wound and unite it to e anterior parietal peritoneum in the following manner: Evert one edge f the abdominal wound so as to expose the anterior parietal peritoneum a point far from the middle line. This is easy because the belly-wall which s much distended by the ascites is now quite lax after the removal of the d.

ture the edge of the omentum to the parietal peritoneum as far from the

middle line as possible. Continue this suture until the middle line is reached. Do the same on both sides.

Method B.—After everting the anterior belly-wall as in Method A, make a transverse incision through the peritoneum and suture the edge of the omentum into this transverse wound.

Step 4.—Close the abdomen with or without drainage.

On the whole, the results of the Morison-Talma operation have been very fair. The death rate has been high—approximately 20 per cent.—but one must remember that any patient requiring the operation is at best "a bad risk." The best results have been obtained in patients operated on early; some of the results have been most gratifying.

In the "American Journal of Surgery" (June, 1909) are published the following statistics of omentopexy and its modifications: 1565 cases; 30.4 per cent. cured; 19.8 per cent. relieved; 39.2 per cent. not relieved; 10.6 per cent. died. "The greatest variation—5 to 23 per cent.—is in the percentage of deaths, and this is found to depend on the variation in the length of the post-operative period on which the different mortality statistics were based."

Bindi thinks that omentopexy not only produces new and free anatomical connections between the portal and systemic circulation, but that it awakens and increases the absorbent power of the peritoneum.

Maiochi reported seventeen cases of operation for cirrhosis (ascites) without death due to operation. Some of the cases were observed for five years and four seemed to be cured of their symptoms.

Schiassi's Method.—"Schiassi makes a vertical incision a little below the left costal margin opposite the middle of the clavicle, and another one running outwards from the upper end of the first incision. A triangular flap consisting of all the tissues to the peritoneum is then raised, and a vertical incision made in the peritoneum. The spleen and the great omentum are withdrawn sufficiently to allow the surgeon to fix them in the wound which is then sutured" (Jacobson and Rowlands).

Mayo's Method.—Mayo makes an "incision on the right side over the liver, in line with the deep epigastric and internal mammary vessels, so as to explore its surface. A second incision is made four inches below this through the rectus muscle but not through it posterior sheath. The posterior sheath is extensively separated from the muscle and a portion of the omentum drawn out of the upper incision and, with a pair of forceps, pulled down into the pocket, bringing it directly in contact with the larger vessels. This can be repeated on the opposite side and the intervening segment attached to the whole front of the parietal peritoneum after the plan of Morison."

Narath's Method.—Narath has modified the Talma-Morison operation as follows ("Zentralblatt für Chir.," 1905, No. 32):

1. Under local anesthesia open the abdomen just above the umbilicus and to the left of the round ligament.

2. Thoroughly drain away the ascitic fluid from all dependent parts of the abdomen.

3. Pick up and pull out of the wound a large segment of omentum. This portion of omentum should be well provided with vessels and its pedicle should be as thick or thicker than a finger. The tension exerted on the omentum must not be so great as to disturb the position or motility of the transverse colon.

4. With sutures partially close the wound in the peritoneum and abdominal fascia, being careful not to cause pressure on the protruding omentum. With a few fine sutures anchor the pedicle of omentum to the peritoneum.

5. By blunt dissection form a subcutaneous pocket to the left of the wound and into this pocket tuck the 4 or 5 inches of omentum which protrude through the belly-wall.

6. Close the cutaneous wound and apply dressings which will not injuriously press upon the omentum in its subcutaneous position.

Corson ("Annals Surg.," Dec., 1907) is an enthusiastic advocate of Narath's method. For reasons which will be given later the author believes this modification of omentopexy to be valuable.

A number of surgeons, notably Delageniere, advocate performing cholecystostomy in addition to omentopexy. *If* the patient's general condition justifies this additional step it is calculated to be of some value.

Encouraged by the success following omentopexy and believing that success to be due to the passage of blood from the portal to the systemic circulation through the omental adhesions, some surgeons sought for a more direct method of attaining the same end. The experiments of Eck showed the feasibility of establishing an anastomosis between the portal vein and the inferior vena cava. Tansini proposed applying this procedure to man and Vidal was the first to carry it out. Unfortunately, as Guibé writes, "this operation ought to be abandoned because, however efficient it may be, it exposes the patient to too great dangers—the danger of alimentary intoxication which might possibly be foreseen and avoided, but specially the danger of a general infection of intestinal origin, since the intestinal mucosa does not always oppose a sufficient barrier to microbic invasion. The patient operated on by Vidal died after four months with evident signs of a sudden general infection." A patient operated on by Thierry de Martel died of anuria in 48 hours. Villard and Tavernier anastomosed a mesenteric vein to the right ovarian, but the opening became occluded by a clot.

II. Operations for ascites aiming at the removal of the effused fluid.

Paracentesis Abdominalis.—The bowels and bladder have been emptied. Thoroughly cleanse the abdomen. Place the patient (unless too weak) in a sitting posture. Place a binder around the abdomen in such a manner that it can be continuously tightened by an assistant standing behind the patient. The binder must be provided with an opening in front through which the operation may be performed. Percuss the abdomen to find the limits of the contained fluid. Choose the site of operation, usually in the linea alba midway between the umbilicus and pubis. Anesthetize the skin by injecting a few drops of weak cocaine solution. Puncture the skin with a tenotome.

Through the puncture insert a trocar and cannula of medium size. Withdraw the trocar. Permit the fluid to escape and as it escapes have the binder tightened. Should the patient show signs of faintness stop the flow of fluid until he recovers.

When all the fluid, or as much as seems proper, has been withdrawn, remove the cannula. A stitch to close the puncture may be necessary occasionally. Apply dressings. Keep a snugly fitting binder around the abdomen.

Permanent Abdominal Drainage.

Lambotte's Method.—Tie a large knot about 2½ inches from the end of a thick silk thread about 18 inches long. Make a small opening into the abdomen; introduce the knot and short free end of the silk into the peritoneal cavity; close the deep abdominal wound around the silk thread. (The knot in the thread is to prevent the thread being pulled out of the abdomen.) With a long probe push or pull the long end of the thread subcutaneously from the abdominal wound to about the middle of the thigh. In Lambotte's case there was great improvement by the fourth day. Marked œdema was noted along the course of the thread. Unfortunately the thread, becoming imbedded in the abdominal wall, no longer reached the peritoneum and thus the ascites returned.

Handley has operated in a similar fashion ("Brit. Med. Journ.," April 16, 1910). The abdomen was opened in the left semilunar line; "a stout needle threaded double with lymphangioplasty silk was now passed in and out in a series of loops through the peritoneal and subperitoneal tissues of the right iliac fossa external to the mesocolon. Short loops of the silk were left exposed within the peritoneal cavity, whence they could suck up fluid by capillary attraction. The process was repeated with two other threads. The four threads were conducted in the manner described to a point close to the anterior superior spine. With the aid of a long probe they were then thrust beneath the outer end of Poupart's ligament some way downwards into the subcutaneous tissues of the thigh. The abdominal wound was now closed in such a way that the sutures used proved additional permanent channels for the escape of fluid from the peritoneal cavity. A number of thick silk ligatures were employed taking up the peritoneum and the muscular layers of the abdomen but leaving out the skin. These were tied and the skin was then closed over them with a continuous superficial suture." The result of the operation was excellent. Œdema under the abdominal skin showed that the silk used in suturing was acting as desired, but the right leg and thigh so far from being œdematous were slightly smaller than the left. It seemed as if the silk threads passed into the thigh were useless. Seven months after operation a condition arose which seemed to show that these threads were useful and that drainage had been taking place all the time without causing evident œdema, and further that if the absorptive power of the tissues is normal and the amount of fluid led into them is not excessive, then œdema need not be expected.

Henschen ("Zent. für Chir.," Jan. 11, 1913) operates as follows: Make a semilunar incision (convexity posterior) through the skin above and external

o the iliac spine; undermine the skin towards the base of the flap outlined. Opposite the base of the skin flap make a small incision through the aponeurosis and muscles at right angles to the direction of their fibres and thus form a tunnel about the size of a finger through the parietes. Open the peritoneum. With fine, interrupted silk sutures stitch the thickened ring at the base of a rubber finger-cot to the peritoneum all round the incision in it. Cut away the blind end of the finger-cot at such a level as to leave the attached segment protruding about 3/4 inch beyond the external aponeurosis. Suture the protruding end of the finger-cot circularly to the wound in the aponeurosis. Close the skin wound.

Henschen remarks that a similar method might be used to conduct ascitic into the loose lumbar retroperitoneal cellular tissue.

Peter Paterson (Lancet, Oct. 29, 1910) makes a small incision through the peritoneum and introduces a glass button. This button measures about 1 inch across the flanges, 3/4 inch between the flanges and has a canal 1/12 inch wide. The flanges are about 1/16 inch thick. The length of the cylindrical part should vary in different buttons as this part must pass through the abdominal muscles. When in place one flanged surface lies inside the peritoneum and the other outside the muscles in the subcutaneous fat. Before placing the button in position any of the omentum which might plug the inner end of the button must be excised.

Drainage through the Femoral Canal.—Acting on a suggestion made by Wynter, Handley has opened the peritoneum through the femoral canal and sutured the edges of the peritoneal wound to the surrounding tissues in such a manner as to prevent its closure if possible. The skin wound is of course completely closed. The object of the operation is to conduct the ascitic fluid into the subcutaneous tissues of the thigh whence it may be absorbed.

Although femoral drainage gave at least one brilliant result, yet the new formed canal usually becomes closed or plugged and failure results.

Direct Drainage into Veins.—The vein suitable for use in this operation is the internal saphenous, for the following reasons: (1) It is conveniently situated; (2) it is large enough to permit of easy manipulation; (3) it is provided with efficient valves near its mouth (the operation is contraindicated when varicosity of the vein renders the valve useless); (4) it does not belong to the portal system.

As a preliminary to operation always make sure, by culture and inoculation, that the ascitic fluid is sterile. This is of *great importance.*

Step 1.—Make an incision in the inguinal region along the course of the internal saphenous vein. Expose and liberate the vein from its junction with the femoral downwards for about 4 inches, *i.e.*, free enough of the vein to reach, *without tension*, a point on the abdomen just above Poupart's ligament. Divide the vein at the selected point and ligate the peripheral segment.

Step 2.—Wash away blood from the vein with warm salt solution. Smear the cut end of the vein with vaseline and protect the vein from drying.

Step 3.—Open the abdomen a short distance above Poupart's ligament

preferably by means of the muscle-splitting method. With closed forceps make a subcutaneous tunnel from the incision in the groin to the abdominal incision. Pass the mobilized segment of vein through the tunnel and suture its open end to the opening in the peritoneum. This suturing ought to be done after the Carrel method of arteriorraphy, with vaselinized silk.

Step 4.—Close the wounds. Before closing the abdominal wound it may be necessary to divide a few muscle fibres so as to prevent pinching of the vein as it passes through the parietes.

Routte ("Lyon Chirurgical," March, 1910; "La Presse Med.," June 25, 1910) performed this operation in January, 1907, on a very unfavorable subject. For a month everything went well but after that time Routte performed the operation on the opposite side and the patient died three days later from grave cardiac disease.

Routte's second patient was a man of seventy. The operation was performed on both sides at the same sitting. The patient remained apparently well for over eighteen months after which time he was lost to sight.

Out of five patients operated on by Routte, in two the result was negative; out of three operated on by Ito and Soyesima there was but one success, but that was secured in a man of thirty-eight who had been tapped seven times, been subjected successively to omentopexy, renal decortication and to an attempt at drainage into the subcutaneous tissues by means of a buried cannula.

Remarks.—Operations which promise even a very moderate amount of success are thoroughly justifiable in such a fatal condition as ascites due to hepatic cirrhosis.

The patients are usually in such poor condition that they are incapable of withstanding any severe intervention.

Narath's modification of omentopexy seems superior to the Talma-Morison operation in that it probably establishes a permanent and efficient drainage of the ascitic fluid into the subcutaneous tissues by means of the herniated omentum.

Wynter's remarks quoted by Handley are very weighty:

"The treatment of ascites by repeated paracentesis, commonly employed in hepatic cirrhosis, has proved unsatisfactory, inasmuch as in the majority of cases the fluid returns within a few days, and the patient is confined to bed or hospital for the remaining brief period of life, which seldom extends beyond two or three months.

"The steady downhill course and rapid loss of strength after paracentesis has been inaugurated indicate that the patient pays dearly for the relief of distention by the sacrifice of so much nutrient fluid, whose speedy replacement drains the blood and tissue and starves the kidneys. The objects aimed at by the method of subcutaneous drainage are:

"1. The saving of nutrient material to the patient.

"2. To ensure an adequate outflow of urine from the kidneys and a sufficient supply of fluid to the tissues by draining the stagnant pond of the peritoneal cavity.

"3. To enable the patient to leave his bed and to maintain the circulation of the body fluids, especially in the portal and lymphatic systems, by means of exercise.

"4. To relieve intraabdominal tension, and thus promote lymphatic absorption and the establishment of a good collateral circulation.".

To the author it appears that much of the good obtained from omentopexy may be attributed to permanent drainage accidentally established; that some form of subcutaneous drainage will prove the treatment of choice; that all endeavors after direct anastomosis between the hepatic and systemic circulation are unjustifiable.

CHAPTER XXXIX

RETRO-PERITONEAL NEOPLASMS

Solid retro-peritoneal tumors may be lipomata or sarcomata. The method of operating is the same for both classes of tumor though when sarcoma can be definitely recognized after opening the abdomen it is hardly worth while to endeavor to remove it, unless in an attempt to relieve distressing symptoms. The mortality after removal of lipomata has been high because of the late stage in which operation has been undertaken.

In operating it is well to remember that retro-peritoneal lipomata arise principally from the perineal and the mesenteric fat. They may be of enormous size.

B. J. Johnston (of Belfast) in 1905 removed easily and apparently completely, a lipoma weighing 21 pounds from beside the right kidney. After two years he removed one of 12½ pounds from the same site in the same patient. There was no evidence of malignancy. George Ben Johnston (Journ. A. M. A., Oct. 22, 1914) reports two cases of retro-peritoneal lipoma operated on by himself and gives a good review of the literature.

Retro-peritoneal tumors in their growth necessarily push the intestines in front of them or to one side; if they arise near the base of a mesentery they grow into the mesentery, the vessels of which become spread over them; they can surround important structures such as the kidneys, the inferior vena cava, etc.; they may contract adhesions with their surroundings so that removal becomes difficult or impossible or they may be easily shelled out of their bed. Diagnosis is rarely made before operation, the condition presents itself to the surgeon as a surprise when he has opened the abdomen for exploration or on an erroneous diagnosis.

The rules to be observed in operating are: (1) Secure free exposure so as to judge if it is justifiable to attempt removal and, if removal is attempted, to do the operation as far as possible under guidance of the eye. (2) Divide the peritoneum covering the growth sufficiently to secure free exposure but in such a manner as to avoid injury to the intestines or their blood supply. If the nutrition of a segment of intestine is cut off, that portion of gut must of course be removed. (3) In separating the tumor from such structures as the inferior vena cava or the iliac veins, rather leave a portion of the tumor *in situ* than hazard their integrity. If it is impossible or improper to avoid injury to very large and important veins their wounds must be sutured at once *secundum artem*. (4) If a kidney is included in the growth and is not readily separated it may be well to remove it always provided that the opposite kidney is intact.

The following description of an operation by Fritz König (Berliner Med.

Woch., 1900, No. 28) is instructive as a type "the peritoneal cavity was opened above the navel through a median incision which extended from the ensiform to the pubis, but neither omentum nor intestine could be seen as they were displaced upwards into a small cavity. The posterior parietal peritoneum lay before us, pushed far forwards by a yellowish tumor. The reflection of the posterior peritoneum on to the anterior parietes formed a fold about a handsbreadth below the umbilicus. The posterior peritoneum was incised in the direction of the external wound and as the lobulated tumor seemed to be a lipoma its extirpation was begun. Vessels, especially mesenteric vessels did not seem to run deeply in the interlobular clefts. The tumor was firmly attached posteriorly and seemed to arise from the pelvis. The peritoneum which covered only the upper third of the tumor, was separated with difficulty; sharp and blunt lateral reflection of the soft parts covering the lower portions of the tumor was likewise difficult. During the enucleation much effort was required to lift the enormous tumor away from the posterior abdominal wall. The urinary bladder was not seen nor could one feel a catheter which had been introduced into it. During the dissection of the right posterior part of the growth a band was found passing backwards between two of its lobes. On division this was found to be the median ligament of the bladder dragged there by the bladder which lay behind the tumor.

On the left side the iliac veins were so united to the tumor and its capsule that they required to be freed by sharp dissection. The left vas deferens (leading to an atrophied inguinal testis) was so surrounded by neoplasms that it had to be divided. On the right side the vas and blood-vessels were not involved. . . . The tumor was removed in one piece except for a few fragments left attached to the left iliac veins. During the excision a vein deep in the pelvis was lacerated but lateral ligation of its wall was effective. In the enormous wound the bladder lay to the right of the pelvis in the sacral cavity, to the left was the rectum and above were the retro-peritoneal tissues. The rapid filling of the dilated veins especially about the cæcum was very striking in a peritoneal cavity which had been compressed into a very small space." The peritoneum was sutured but the pelvic cavity was packed with iodoform gauze.

Retro-peritoneal Cysts.—Dermoid cysts from an operative standpoint may be considered in the same class as lipomata while hydatids ought to be treated in much the same fashion as those of the liver. The other forms of retro-peritoneal cysts appear in literature under various names such as pancreatic, pseudo-pancreatic, renal, mesenteric, etc., etc. Dowd (Annals Surg., xxxii, 515) believes that many of the cysts published as "chylous," "sanguineous" etc., arise from sequestrations from the primitive organs of generation. Donoghue (Journ. A. M. A., Dec. 22, 1906) has similar views. In International Clinics iv, 1906, the author wrote, "In the literature on cysts of the lesser peritoneum one finds few reported, apart from those credited to the pancreas; it is often so difficult, or even impossible, to recognize during operation the precise origin of any individual cyst; there are so many possible sources from which cysts may develop that one is forced to believe that operators and writers have too often

assumed their pancreatic origin without sufficient diagnostic data." The operative treatment of retro-peritoneal cysts varies according to circumstances. If the cysts lies behind the ascending or descending colon it ought to be approached through an incision in the parietal peritoneum just external to the colon, in fact through such an incision as is used in mobilizing the colon in colectomy. If the cyst occupies the lesser peritoneal cavity (pseudo-pancreatic cyst) it may be approached through the gastro-colic omentum; if it lies in a mesentery it must be approached through the peritoneum of the mesentery, very great care being taken to incise as far from the gut as is possible and to avoid injury to the mesenteric vessels for fear of jeopardizing the nutrition of the gut. Once the cyst wall is exposed two methods of treatment may be available. (*a*) If it is easy to separate the cyst wall from its surroundings, with or without evacuation of its contents, do so. Usually the cavity left is at once obliterated by the collapse of its sides, otherwise it may be necessary to insert a drain. With sutures, close any peritoneal wound. (*b*) If enucleation of the cyst seems difficult or threatens the integrity of some important structure, make an opening into the cyst and evacuate its contents. Remove as much of the cyst wall as possible but leave enough to permit of its suture to the abdominal wall without tension. Suture the edges of the wound in the cyst to the parietal peritoneum and deep aponeurosis. (When the cyst is situated in the flanks it may be better to secure the marsupialization through a postero-lateral incision and to close the original abdominal wound.) Sometimes after its contents have been evacuated, a cyst which appeared impossible of enucleation may become removable.

If it is impossible or improper to bring the cyst into contact with the abdominal wound place a purse-string suture of catgut around the opening in the cyst, introduce a drain, tighten the purse-string round the drain and with a needle fasten the end of the suture to the tube so that the latter cannot escape before the catgut is absorbed. Bring the end of the tube through the abdominal wound. The technique of drainage in these cysts is very similar to that in cholecystostomy and the results are very good.

If a loop of intestine is inseparably attached to the cyst the two must be removed together.

Pakowski (Internat. Abst., Feb., 1913) extirpated dermoid cysts in 13 cases with 11 rapid recoveries. In 43 cases of dermoids collected by him the site of the tumors was as follows: great omentum 7; lesser omentum 1; lesser peritoneal cavity 3; mesocæcum 1; ascending mesocolon 2; transverse mesocolon 5; descending mesocolon 1; meso-sigmoid 3; in neighborhood of rectum 8; retroperitoneum 12.

CHAPTER XL

THE PANCREAS

The pancreas is so deeply hidden behind the abdominal cavity that it has been much neglected by the pathological anatomists. The fact that, when it is injured, other organs are always notably injured at the same time, and the patient is evidently in a critical condition, has led operators to neglect direct investigation or inspection of the gland. Until very recently the only pancreatic lesions attacked by surgery were cysts. To-day, thanks to the labors of many pathologists, internists, and surgeons, more knowledge has been attained and this "hermit kingdom" is being opened up to surgical therapy.

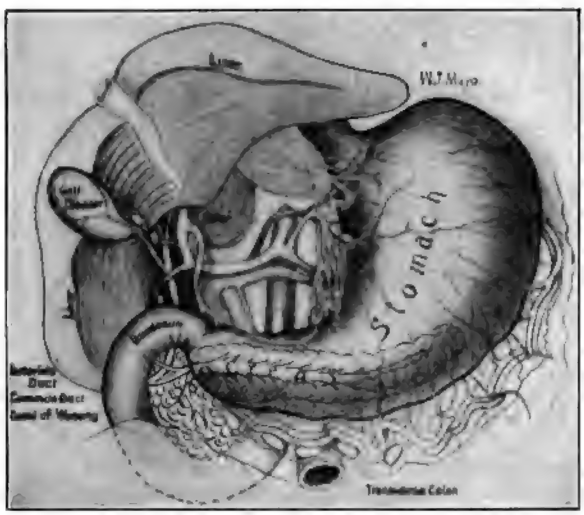


FIG. 627.—Anatomical relations of the pancreas. (*Mayo.*)

The pancreas reaches from the duodenum to the spleen and discharges its secretions through the canal of Wirsung into the duodenum. Before entering the gut the canal of Wirsung unites with the common bile-duct to form the diverticulum or ampulla of Vater (Fig. 627). Besides the main duct or canal of Wirsung, there is a secondary duct (duct of Santorini), which arises from the main duct near the head of the gland and discharges into the duodenum at a slightly higher level. The tail or left extremity of the pancreas lies in front of the left kidney and the suprarenal capsule. The most important vascular relations of the pancreas are the splenic artery on its upper surface, while at its head is the pancreatico-duodenal artery, which forms an arch with the superior mesenteric. The pancreas lies behind the posterior parietal peritoneum and in

front of the lower portion of its head is the transverse mesocolon; in front of its body is the stomach.

There are several routes by which the pancreas may be reached: (1) Through the gastro-hepatic omentum above the stomach; (2) through the gastro-colic omentum below the stomach; (3) through the transverse mesocolon back of colon and the stomach; (4) by retracting inwards the second part of the duodenum; (5) through the stomach; (6) from the loin behind the peritoneum.

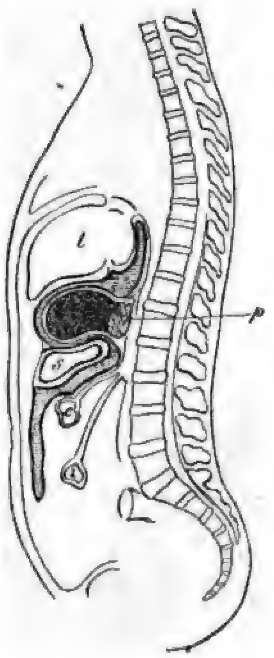
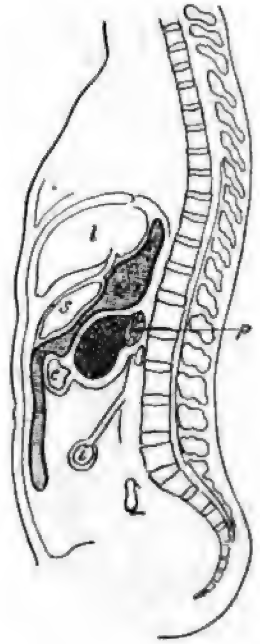
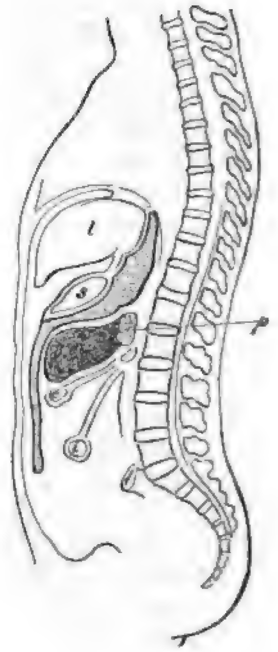




Fig. 628. Fig. 629. Fig. 630.

Fig. 628.—Tumor of pancreas. Stomach and colon both below it. (*Robson and Moynihan.*)

Fig. 629.—Tumor of pancreas. Stomach and colon both in front of it. (*Robson and Moynihan.*)

Fig. 630.—Tumor of pancreas pushing forwards between the posterior layer of the great omentum and the transverse mesocolon. Stomach above, colon beneath it. (*Robson and Moynihan.*)

Operation upon a pancreatic cyst forms a good type on which to base a description of surgical interference.

Step 1.—Open the abdomen in or near the middle line above the umbilicus. If the cyst makes a prominent swelling, it may be well to make the incision, vertically, over its most prominent part. Explore the abdomen, note the presence and extent of adhesions, and where the cyst presents. This may be above, behind or below the stomach, behind or below the transverse colon (Figs. 628, 629, 630, 631, 632).

Step 2.—(A) The cyst presents or is most prominent above or behind the stomach. Make a vertical tear through the gastro-hepatic omentum; this at once exposes the cyst. Endeavor to explore the relations of the cyst, but do

ot persist in the exploration if great difficulties arise, lest harm result. In a ew instances it may be found possible to excise the disease; most commonly marsupialization is the operation of choice.

(B) The cyst presents between the stomach and transverse colon, behind the colon, or behind the stomach. Make a vertical tear through the gastrocolic omentum and expose, explore, and treat the cyst. J. D. Malcolm ("Lancet," June 16, 1906) completely and successfully removed a multilocular cystic

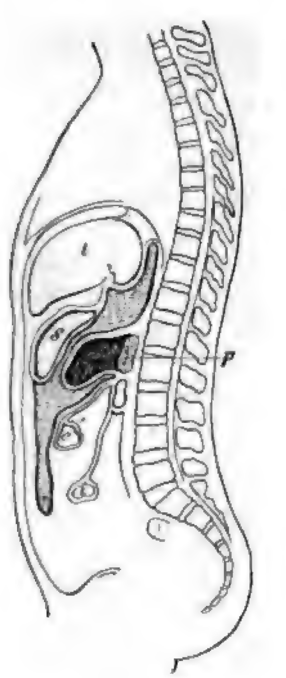


FIG. 631.

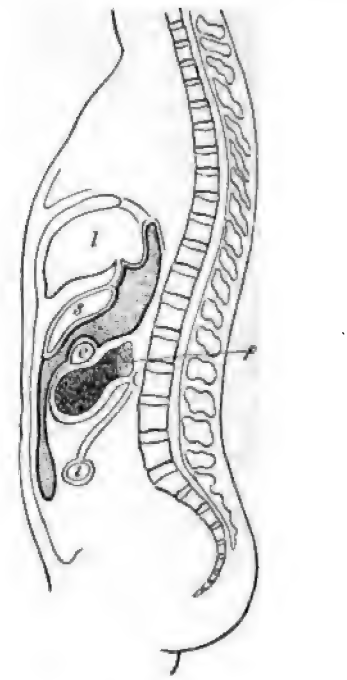


FIG. 632.

FIG. 631.—Tumor of pancreas. Stomach in front, colon below it.—(*Robson and Moynihan.*)

FIG. 632.—Tumor of pancreas. Stomach and colon both above it.—(*Robson and Moynihan.*)

tumor through this route. Both layers of the transverse mesocolon were divided; the wound in the inferior layer was sutured. Although the pancreas itself was incised this gave no subsequent trouble, probably because drainage was established posteriorly below the twelfth rib. Acute flexion at the splenic angle of the colon necessitated colo-colic anastomosis on the sixteenth day after the primary operation. Recovery.

(C) The cyst presents behind or below the transverse colon. Pull the transverse colon and great omentum out through the belly wound and turn them upwards exactly as is done in posterior gastro-enterostomy. In an avascular area of the transverse mesocolon make an appropriate tear and expose, explore, and treat the cyst. Do not injure the mid-colic artery or any of its main branches.

(D) Kõrte has reached the head of the pancreas by forcing his way along the side of the duodenum after incising its peritoneal covering. This is very similar to Vautrin's method of reaching the lowest segments of the common bile-duct.

(E) *Transgastric route:* Hagen ("Archiv f. klin. Chir.," lxii, 157) reports a case in which complications compelled him to attack the cyst after incision of both the anterior and posterior gastric walls. The stomach was inseparably and indistinguishably adherent to the cyst. It was impossible to reach the cyst and bring a portion of its wall to the parietes by any ordinary means. Hagen made a two-inch incision through the anterior wall of the stomach and a small one through the posterior wall. There was no line of demarcation between the stomach and cyst-walls. After evacuation of the contents the cyst was explored with the finger. It was possible with care to bring a small area of cyst-wall to the parietes, to the left of the great curvature, below the ribs, behind the left gastro-epiploic artery and vein. Before the selected portion of cyst-wall could be united to the parietes it was necessary to resect the cartilages of the ninth and tenth ribs on the left side; this permitted the soft belly-wall to sink inwards and meet the cyst-wall as it was elevated. Closure of the gastric wound by suture and marsupialization of the cyst completed the operation. Recovery. Hagen considered the possibility of lumbar drainage, but in his case it was out of the question.

(F) *Lumbar route:* Remember that the tail of the pancreas lies in front of the left renal vessels, hence any portion by which the hilus of the kidney is exposed will also give access to the left extremity of the pancreas. Exposure of the kidney through the loin is so fully discussed elsewhere, and exposure of the tail of the pancreas is so similar, that further description is unnecessary here.

In the course of transperitoneal operations it is often advisable or necessary to provide lumbar drainage. To effect this, explore the cyst with the finger; guided by the finger and carefully avoiding all important structures such as the renal vessels, etc., push a closed forceps through the posterior parietes below the twelfth rib and immediately external to the erector spinæ muscle. Incise the skin and deep fascia at the point made prominent by the forceps. Make the opening large enough to avoid compression of the tube or gauze used for drainage. With the forceps pull a drain (gauze or tube) into position. It is well, when preparing a patient for any operation on the upper half of the belly, in which posterior drainage may be required, to follow Park's advice, and clean the lumbar region as well as the abdomen; thus valuable time may be saved in the course of the operation. Deaver's plate (Fig. 633), although drawn to illustrate the relations of the kidney, illustrates the important anatomical relations of the pancreas, especially with regard to exposure through the lumbar route. Only the head and tail of the pancreas are accessible by this posterior route, the tail being more easily reached than the head. Peters was successful in exposing and draining a hydatid cyst of the tail of the pancreas through the left lumbar route.

Step 3.—*Treatment of the cyst.* Dangers: The dangers inseparable from operations on the pancreas are less pronounced in cystic than in other diseases or lesions. It will be convenient, however, at this time, to discuss the dangers of pancreatic operations in general; v. Mikulicz gives a good résumé of these in his paper on "The Surgery of Trauma and Inflammatory Processes in the Pancreas" ("Transactions of the Congress of American Physicians and Surgeons," 1903).

1. Hemorrhage. The pancreas is exceedingly vascular; its tissues are fragile, and hence simple ligature is often entirely ineffective. Sutures involving a mass of healthy or uninjured tissue, as well as the bleeding area, are necessary

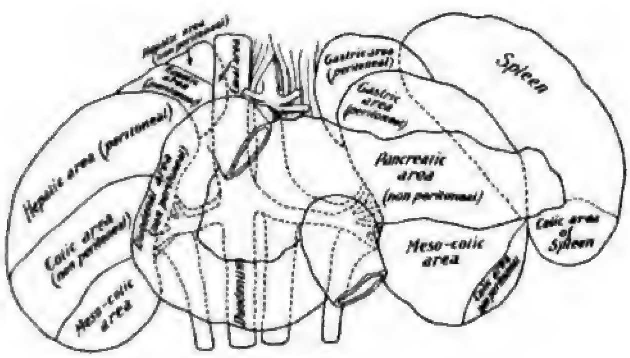


FIG. 633.—Relation of pancreas. (*Denver.*)

in spite of the dangers from necrosis incident to the use of mass ligatures. Secondary hemorrhage is common. It is wise, when possible, to prepare the patient, prior to operation, by the exhibition of large doses of chloride of calcium, as recommended by Mayo Robson in cases of jaundice.

2. Leakage of pancreatic juice into the parenchyma of the gland and the surrounding peritoneal structures constitutes a greater danger even than bleeding. The juice, even when sterile, does much positive damage; it also diminishes the resisting power of the tissues so that the mildest form of infection, ordinarily harmless, becomes of the gravest significance. Infection is liable to reach the injured area through the pancreatic duct from the duodenum in the same manner as it passes up the common bile-duct. Fat necrosis and pancreatitis, both chronic and hemorrhagic, may be occasioned by trauma, and hence may result from operation. Peritonitis is very liable to result from pancreatic leakage. This peritonitis may be aseptic and is frequently followed by intestinal paralysis, leading to rapidly developing obstruction, which often so modifies the symptoms as to lead to a serious mistake in diagnosis (v. Mikulicz). During excision of gastric cancer portions of the adherent pancreas may be shaved away, hemostasis being attained by sutures and by covering the wound with peritoneum. The fact does not negative the value of the preceding remarks as in gastric cancer where portions of the pancreas must be sacrificed, these portions

have been subjected to simple or adhesive inflammation and thus are prepared for operation.

3. It has been shown that by the time such definite symptoms of pancreatic disease arise as diabetes or severe disturbance of its fat-digesting function, there is, as a rule, already such great destruction of its substance that surgical interference is not admissible. The author operated on one case of very recent pancreatic diabetes in the hope that drainage might relieve the inflammation to which it was believed the disease was due; the patient did not survive more than twenty-four hours. Nash ("Lancet," Nov. 1, 1902) reports a case of pancreatic glycosuria associated with cholelithiasis in a man of sixty years After removal of a large calculus from the gall-bladder, recovery ensued. The urine four months after operation was free from sugar. In Woolsey's three successful operations for acute pancreatitis only one had glycosuria.

Mayo Robson ("Brit. Med. Journ.," April 23, 1910) after discussing the value of Cammidge's reaction as a means of diagnosing pancreatic disease before and after the appearance of glycosuria, comes to the following conclusions:

1. That the early recognition and treatment of interstitial pancreatitis, or of pancreatic catarrh, by drainage of the bile-ducts, and thus indirectly of the pancreatic ducts, and the removal of the cause, whether that be gall-stones, duodenal ulcer, or other conditions, may be the means of averting diabetes.

2. That in certain diseases of the pancreas, even after the appearance of glycosuria, surgical treatment is well worth considering, as in a number of cases it has lead to a complete disappearance of sugar from the urine, and in others to an arrest of the disease causing glycosuria.

3. That every case of diabetes should be considered from its etiological point of view, seeing that certain cases of glycosuria of pancreatic origin are curable, and in others the progress of the disease may be arrested by suitable surgical methods that can be carried out with small risk.

Robson reports a number of cases which support these conclusions.

(A) *Excision of the Cyst.*—This operation is suitable only in cases where adhesions are few or where the cyst has become pedunculated. Ransohoff has collected 23 cases of enculeation with 2 deaths. The operation requires no special description, as the surgeon must follow the common principles of surgery after the tumor has been exposed by one of the methods described above. v. Mikulicz lays down the absolute rule that whenever the pancreatic tissue has been exposed, drainage is requisite.

(B) *Marsupialization or Drainage.*—Expose the cyst by any of the methods described. Protect the peritoneal cavity thoroughly with pads. Note the part of the cyst which can be most readily brought into apposition with the abdominal wall. If the site of the primary abdominal incision proves unsuitable, a secondary incision may be made. If the cyst is very tense, empty it, at least in part, by means of the aspirator. Suture the cyst-wall to the parietal peritoneum. Explore the cyst cavity. Especially note if the tumor is a true pancreatic cyst, *i.e.*, one arising in the gland itself; or a false one, *i.e.*, a collection of fluid in the lesser peritoneal cavity due, as a rule, to injury or disease of the pan-

creas. If necessary, provide drainage by means of lumbar puncture. Provide tubular or gauze drainage of the cyst or a combination of tubular and gauze drainage. If the cyst-wall is of suitable consistency, it is well to fix a "dressed drainage-tube" into it, exactly as is done in the case of the gall-bladder. If the cyct-wall is too thin to be sutured with safety to the parietes or if it cannot be brought to the abdominal wound, protect the peritoneum with gauze packing around a tube which leads into the cyst. As a whole, the methods of draining pancreatic cysts are identical with those for draining the gall-bladder, but in the case of the former greater danger is to be feared from the effects of the leakage of fluid into the peritoneum. Having provided for drainage, close the excess of wound in the abdominal wall.

Usually, under the above treatment, the cyst shrinks and becomes obliterated. Occasionally a fistula persists.

Wohlgemuth and Karewsky have found that persistent pancreatic fistulæ close promptly when the patients are put on rigid antidiabetic diet. Walter Schmidt ("Muench. med. Woch.," Dec. 10, 1907) reports having excised a pancreatic cyst: the gland was injured, drainage provided, antidiabetic diet was ordered; everything went well until, on the thirteenth day after operation, a more liberal diet was permitted when the discharges became more profuse and continued so until the rigorous diet was reëstablished.

Solid tumors of the pancreas are rarely suitable for operation. Ruggi, in 1890, and Gade, in 1895, successfully removed tumors from the tail of the pancreas; most of the other cases reported promptly died.

Excision of the Head of the Pancreas.—The author is unaware of any operation actually performed for the excision of the head of the pancreas and the duodenum, but the steps of the operation as elaborated, on the cadaver, by Desjardins ("Rev. de. Chir.," June, 1907) teach so many valuable lessons that the method demands attention. Various items of the operation are well calculated to assist a surgeon when attacking such conditions as malignant disease of the duodenum near the ampulla of Vater, etc. Desjardins remarks that if the length and complexity of the operation demands it, the procedure may be carried out in two sittings. At the first sitting a gastro-enterostomy (en Y) is done, the jejunum being divided lower than usual, about 8 inches from its origin. At the second sitting the head of the pancreas is removed along with the duodenum and the double anastomosis of the bile-duct and the pancreas carried out. This second operation consumes about the same time as does an ordinary pylorectomy.

Desjardins' Operation.—There are three special anatomical dangers to be overcome in the operation:

a. In certain cases the upper end of the ascending colon lies directly on the right surface of the descending duodenum and is hence in danger of injury when the duodenum is being mobilized.

b. At the third portion of the duodenum the superior mesenteric artery and vein emerge from under the lower edge of the pancreas and pass over the front of the duodenum. The middle colic artery arises from the superior mesen-

teric and courses through the transverse mesocolon; it is easily injured and injury leads to gangrene of the gut it supplies. The mesenteric artery, lying to the left of its companion vein, is situated in the groove which separates the body from the neck of the pancreas; it runs downwards and to the right in a curve which is convex towards the left; from its concave or right side as soon as it emerges from the pancreas it gives off the colic arteries. To the left of the superior mesenteric vessels there is an avascular region in which there is no vessel except the pancreatico-duodenal, and it can be safely tied.

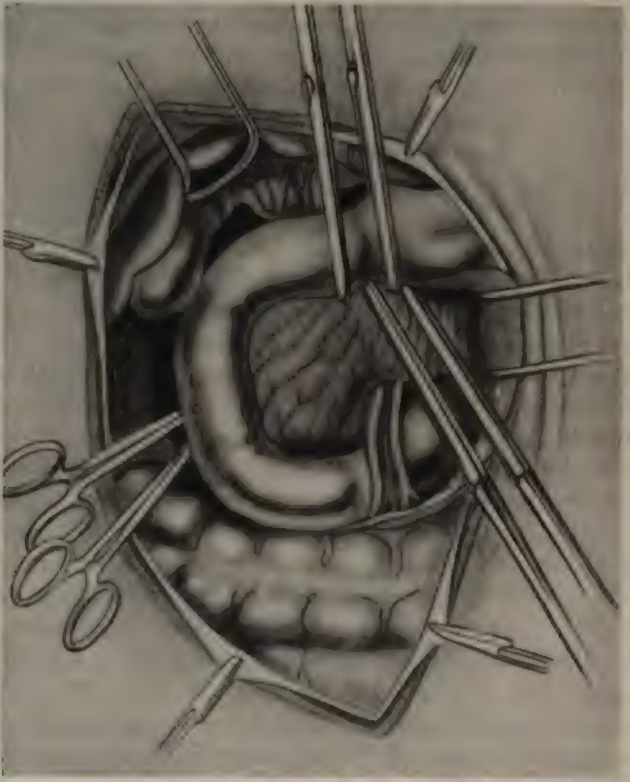


FIG. 634.—Excision of head of pancreas. (*Desjardin.*)

c. Behind the pancreas and close to it, lie the portal vein and the inferior vena cava.

Place the patient in Robson's position.

Step 1.—Make a median incision from a point on the level of the tip of the ninth rib, downwards to near the umbilicus. From the upper end of the vertical incision cut upwards and to the right, through the right rectus, until the costal margin is reached above and to the inner side of the gall-bladder. If more room is required make an oblique cut downwards and to the left from the lower end of the median incision. Before making the two supplementary cuts, introduce the hand and explore the belly.

Step 2.—Push the omentum to the left. Expose the duodenum. Incise the peritoneum parallel to and about ¾ inch from the descending duodenum after noting that it is not adherent to the ascending colon. Through the peritoneal wound separate the duodenum from the posterior belly-wall until the portal vein and vena cava are passed. The head of the pancreas can now be completely explored and even brought almost out of the wound.

Step 3.—Ligate the pyloric and gastroduodenal vessels as in pylorectomy. Divide, between ligatures, the right portion of the great omentum.

[FIG. 635.—Excision head of pancreas. (*Desjardin.*)

Step 4.—Doubly clamp and divide the pylorus (Fig. 634). Pull the mobilized duodenum downwards to expose the common bile duct. If the duct is dilated divide it, between forceps, as low as possible; if not dilated, divide it just below the entrance of the cystic duct. At this stage it may be necessary to cautiously dissect the mesocolon in order to disengage the portion of the duodenum lying under it. Continue the separation of the duodenum until the superior mesenteric vessels are passed and the duodeno-jejunal junction is reached; doubly clamp and divide the gut here.

Step 5.—The pancreas and duodeneum are still attached to each other. Place a clamp on the body of the pancreas (Fig. 634). The clamp must be

directed obliquely upwards and to the right so as to avoid injuring the colic arteries. When so placed, the lower ends of the clamps are remote from the mesentery where the colic vessels arise. Divide the pancreas to the right of the clamp or between the clamps if two have been used (Fig. 635).

Step 6.—Remove the head of the pancreas and the duodenum being careful not to injure the mesenteric vessels which emerge from between these structures.

Step 7.—Close the opening in the stomach where the pylorus was divided. With a Murphy button anastomose the open end of the jejunum to the posterior surface of the stomach.

Step 8.—Anastomose the common bile-duct to the jejunum. If this is impossible because of the small size of the duct, close the duct and anastomose the gall-bladder to the jejunum.

Step 9.—Apply chain sutures to the cut surface of the pancreas but leave the canal of Wirsung free. Isolate about 1 inch of the canal, and anastomose it to the jejunum. This anastomosis is very similar to that between the ureter and the bladder. If Wirsung's duct is too narrow to permit of anastomosis another method must be adopted; often a number of small ducts will be found instead of one; this also demands a change in method.

Alternative Method.—Doubly clamp and divide the jejunum about 12 inches from its origin. Opposite the point of section free and divide the mesentery as much as possible without damaging the blood supply. Anastomose the distal segment of gut to the stomach as in Step 7. A loop of jejunum now lies free except for a loose mesenteric attachment, and open at both ends. Anastomose one end of this loop to the gall-bladder after closing the common duct; into the other open end of the segregated loop, push the divided end of the pancreas and fix it there by sutures introduced as nearly as possible in the Lembert fashion. Make an anastomosis between the middle of the segregated loop of jejunum and that portion which is anastomosed to the stomach. Provide free drainage especially in the pancreatic region.

Acute Pancreatitis.—The tendency at the present time is to operate very early in this most fatal disease. Deaver notes that few patients come under the surgeons care until the second or third day of the disease and that under these circumstances, as in other cases of diffuse peritonitis it is sometimes safer to encourage localization of the process before instituting drainage. This does not mean encouraging delay until the patient is moribund from sepsis. If a case is seen before symptoms of diffuse peritonitis arise no time should be lost before operation is undertaken. The operation consists in an exploratory incision above the umbilicus. In doing this, be on the lookout for patches of fat necrosis; these are yellowish-white patches of various sizes situated in the subperitoneal, mesenteric and omental fatty tissues. Fat necrosis is always indicative of pancreatic disease.

According to indications found after the abdomen has been opened, the pancreas should be exposed either through the great omentum above the colon, or through the transverse mesocolon. The belly cavity must be thoroughly protected by gauze packing. If abscess is present, the pus is now evacuated,

requisite, incision being made into the pancreas for this purpose (case of r. C. B. Porter of Boston, reported by v. Mikulicz, "Trans. Am. Cong. ıys. and Surg.," 1903). Sloughs and gangrenous tissue should be removed ıd drainage provided. In spite of all care and thoroughness in operating, e disease continues to prove most fatal.

Subacute Pancreatitis.—The operative treatment of subacute pancreatitis practically the same as that of pancreatic cysts and requires no special iscussion. Mayo drained, with success, one case of this nature through the ıll-bladder, as is done in chronic pancreatitis.

Chronic pancreatitis is treated by cholecystostomy or cholecystenterostomy.

Robson ("Surg., Gyn., Obst.," Jan., 1908) finds that of one hundred and wo operations in patients in whom chronic pancreatic trouble was the chief lisease, or where it formed a serious complication of other diseases, 96.1 per ent. of cases were followed by complete recovery, giving a mortality of 3.9 per cent.; but since these statistics were compiled in 1904 experience has very largely increased and the mortality has diminished to a little over 2 per cent. Of course where biliary or pancreatic stones are present such must be removed.

Ruth ("Colorado Medicine," Oct., 1907) removed a mass of calculi which weighed 280 grains and lay throughout the whole length of the gland. He found the duct walls 1/8 inch thick and very strong.

Pancreatic Lithiasis.—Stones are formed in the pancreatic as in the biliary duct. Calculi existing near the ampulla of Vater may be extracted through a duodenal incision, as in the case of gall-stones. As a rule, the removal of pancreatic calculi has been accomplished incidentally during the evacuation of abscesses in subacute pancreatitis. Moynihan was the first to remove a calculus where the diagnosis had been made prior to operation. When a calculus can be felt in the exposed pancreas it is proper to incise the gland, remove the stone, close the pancreatic wound with sutures, and provide for drainage.

Traumata.—Whenever structures around the pancreas are injured one ought to suspect and look for injury to that organ. When in a case of bullet wound the posterior wall of the stomach is penetrared, it is extremely probable that the pancreas is also involved. Remember, experience teaches that a comparatively slight injury to the gland may lead to disastrous results from leakage of the digestive juice. Lacerated fragments of the pancreas must be removed. Wounds in its substance must be sutured with catgut, care being taken not to occlude the duct by the suture. Whether sutures are used or not drainage must be established, preferably by means of cigarette drains, which may be introduced through the abdominal wound or through a pecial lumbar wound or by both routes. After the pancreatic lesion has been ttended to, it is good practice thoroughly to douche the general peritoneal ıvity with hot salt solution in order to get rid of, or at least dilute, any effused ıncreatic juice.

As anti-diabetic diet diminishes pancreatic secretion (Wohlgemuth), such diet may be of very great value as an adjuvant to the local treatment of juries to the pancreas.

CHAPTER XLI

THE SPLEEN

Surgical Anatomy.—"The spleen is a soft, highly vascular, and easily distensible organ, of a dark, purplish-gray color. It is placed obliquely in the back of the left hypochondrium, between the cardiac end of the stomach and the diaphragm, and in the line of the axilla extends from the eighth to the eleventh rib." Its shape is that of a compressed oval having three surfaces. "Of these, one, the external and posterior, is large and convex, fitting against the commencement of the arch of the diaphragm and looking upwards, backwards, and to the left. A second, the narrowest, is placed vertically, and looks directly inwards, being applied to the outer border of the left kidney; whilst the third surface, which is separated from the last described by a distinct vertical ridge, is larger than it and concave. This surface is applied to the great cul-de-sac of the stomach and is in contact also with the tail of the pancreas and with the extremity of the arch of the colon (splenic flexure). Near the ridge above mentioned there is a vertical fissure in the anterior surface, at the part where the vessels and nerves enter the organ; this part is termed the hilus" (Quain). The spleen is held in place by means of reduplications of peritoneum. Such are the gastro-splenic, pancreatico-splenic, and phreno-splenic ligaments. Occasionally there is a colo-reno-splenic ligament at the lower extremity of the spleen (Villar). The splenic blood vessels are contained in the gastro-splenic omentum. The splenic artery, after giving off the gastro-epiploica sinistra, breaks up into a number of branches, a few of which—the vasa brevia—turn back to the stomach. The remaining branches enter the spleen at the hilus. The splenic vein, in its origin, corresponds to the artery. It is a large vessel and lies below the artery. In its subsequent course it is situated behind the pancreas.

Splenopexy.—Splenopexy is performed for the cure of "floating spleen." Several methods have been devised to anchor the spleen in the left hypochondrium.

(A) *Rydygier's Method.*—Freely open the belly in the middle line. Locate the spleen. Between the ninth and tenth ribs make a transverse incision through the parietal peritoneum (Fig. 636). Introduce the fingers through this incision and separate the peritoneum, below the incision, from the parietes, and thus form a pocket whose mouth is directed upwards (A, A, Fig. 637). The pouch is made sufficiently large to receive the lower end of the spleen. If the spleen (B) is placed in this pouch, its weight may enlarge it so that the operation is rendered useless. To prevent this, insert a few catgut sutures through the peritoneum and part of the parietes immediately below the lower limit of the pouch. These will prevent further separation of the peritoneal flap from the parietes. Place the lower end of the spleen in the pouch. Unite the free edge

of the peritoneal flap, forming the pouch, to the gastro-splenic ligament by one or more sutures. If it seems desirable, suture the spleen itself to the peritoneal incision, or form, from the peritoneum above, a flap with its base next the spleen; reflect this flap over the spleen and suture it to the gastro-splenic ligament.

(B) *Bardenheuer's Method.*—Place the patient on his right side. Make an incision in the axillary line, from the tenth rib to the iliac crest. At the level of the tenth rib make an incision at right angles to the first. Divide the soft parts down to the peritoneum. Make an opening through the peritoneum of size sufficient to permit of exploration and of the passage of the spleen through it.

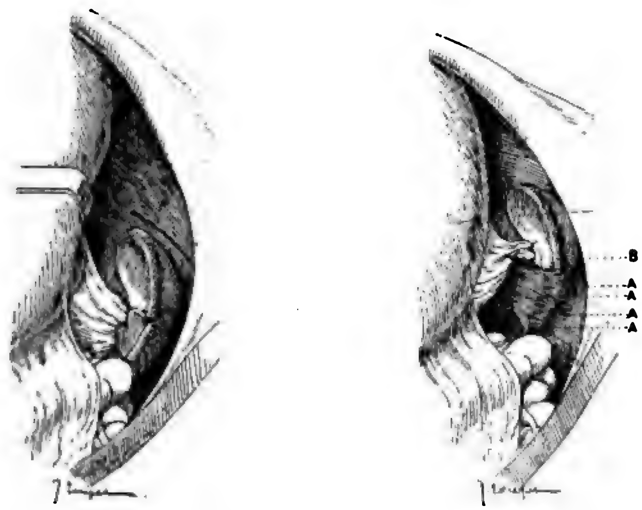


FIG. 636. FIG. 637.

FIGS. 636 AND 637.—Rydygier's splenopexy. (*Monod and Vanverts.*)

Have an assistant, with his hand on the belly-wall, push the spleen towards the wound. Bring the spleen out through the peritoneal wound. With sutures diminish the size of the peritoneal wound and unite it to the splenic pedicle. Pass one stout suture through the lower end of the spleen and tie it around the tenth rib. Close the wound in the soft parts. The spleen now lies with its inferior pole in a retroperitoneal pouch; its pedicle is fixed to the peritoneal wound, and its body is suspended from the tenth rib.

The foregoing operations are so recent that their merits have not been fully tested; probably Bardenheuer's is the safer and easier.

Splenectomy.—The spleen may be removed for the following conditions (Greig Smith):

1. Injury or prolapse.
2. Certain cases of movable spleen.
3. Simple hypertrophy, with or without cirrhosis.
4. Sarcoma or lympho-sarcoma in the early stages.
5. Cysts.
6. Hydatid disease.

To these indications it is safe to add that of Banti's disease or hemo jaundice with splenomegaly. The results of splenectomy in this conditio been most gratifying and surprising. Encouraged by the results obtain Banti's disease Eppinger and Exner performed splenectomy for perni anæmia on March 15, 1913; Decastello and Finsberger did the same, indep ently, on March 20, 1913. Lenormant (La Pr. Med. 23, May, 1914) ana 24 collected cases with 5 deaths. (Two deaths were *perhaps* not due to operation.) In the patients who survived there was rapid and constant provement in the general condition, the appetite improved and weight incre even before there was any improvement in the blood picture. Icterus d peared and there was diminution in the excretion of urobilin. The b picture following operation was rathe regular—in some cases it became excel in others improvement was not so ma Ranzi speaks of the dangers which be present in operation due to adhe to the diaphragm and to a develop and dilatation of vessels almost equiv to aneurysm.

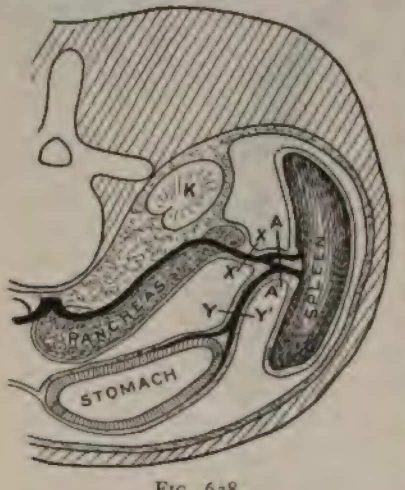


FIG. 638.

In one case reported by Huber the tient showed hemoglobin 10 to 20 cent.; red cells, 1,000,000; œdema; re hemorrhages; slight icterus; urobilin dyspnœa, etc. The patient being weak for operation was given intra- cular injections of defibrinated blood later splenectomy was performed. In weeks after operation the hemoglobin 50 per cent. and red cells $2\frac{1}{2}$ million. In three months the patient could w

Eppinger and Ranzi operated on a moribund patient with only 50 red cells who recovered to such an extent as to be able to do moderate w

It is too early to claim cures in pernicious anæmia but it is certain that sp ectomy has been followed by wonderful improvement.

In cases of leucocythæmia the spleen ought *never* to be removed.

Splenectomy.—Place the patient in an exaggerated Mayo-Robson posi *i.e.*, in marked lordosis.

Step 1. *Method A.*—Make a left rectus incision almost identical Robson's incision for exposure of the gall bladder but on the opposite side.

Method B.—Make an incision parallel to and a little below the costal bo from the epigastrium to a point opposite the end of the eleventh rib from w point the incision may be continued vertically downwards for a short dist if necessary.

Step 2.—Explore the region of the spleen. If adhesions are present n rupture them blindly; usually it is easy to expose, doubly ligate and divide t to the omentum, the colon and the abdominal wall. Adhesions to the

phragm are more difficult to master—if it is impossible to doubly ligate them before division. Hartmann advises that the operation be given up otherwise disaster is invited.

Step 3.—The spleen is now free except for its true pedicle. Deliver from the abdomen first its inferior pole, then its superior. If the spleen is mobile ligate its pedicle by transfixion (A A′, Fig. 638) being careful to cross the threads.

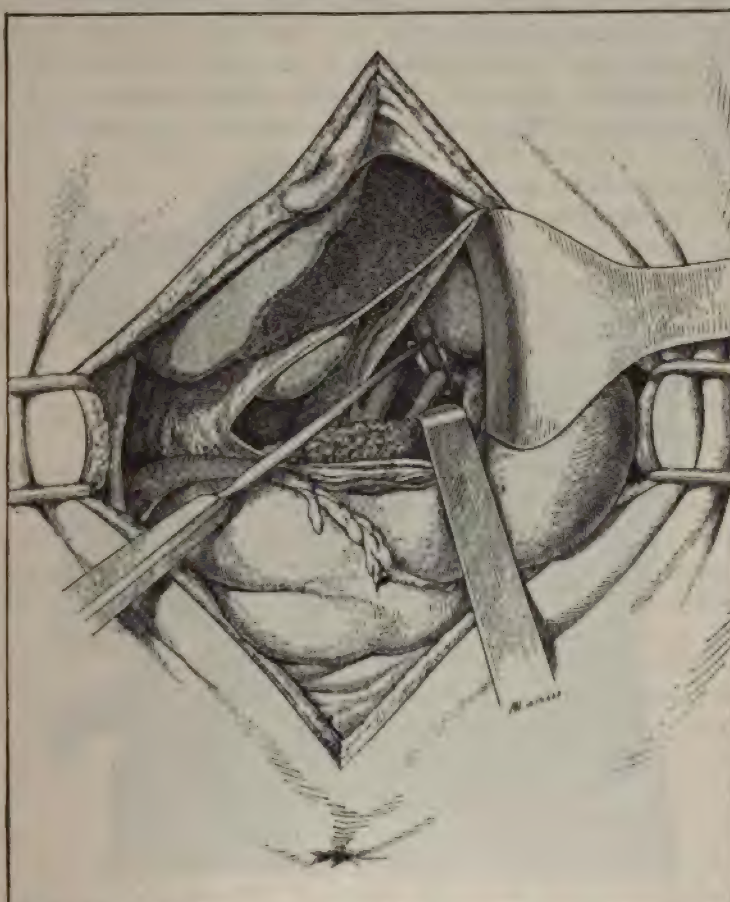


FIG. 639.—Ligation of splenic artery. (*Hartmann, La. Presse Medicale.*)

Apply a clamp to the pedicle near the spleen. Divide the pedicle between the ligatures and the clamps. Remove the spleen. Inspect the ligated stump and apply ligatures to the individual vessels as an additional safeguard. If the spleen is *not* mobile, ligation of the pedicle *en masse* is impossible without ligating the tail of the pancreas at the same time. If time is of great importance this may be done though it is generally better to proceed as follows: Pull and rotate the spleen towards the left so as to expose the gastro-splenic omentum with the *vasa brevia* and the left gastro-epiploic vessels running in it from the splenic

artery to the stomach. Doubly ligate the *vasa brevia* and the left gastro-epiploics (Y Y′, Fig. 638) and divide the gastro-splenic omentum between the ligatures thus gaining access to the lesser peritoneal cavity. Note the pancreas with the splenic artery and vein on it lying behind the posterior peritoneal wall of the lesser cavity. Pick up and incise the peritoneum over the splenic vessels and tie them (X X′, Fig. 638). Remove the spleen. The splenic vessels may be reached not only through the gastro-splenic omentum but through the gastro-hepatic, or the gastro-colic omenta or even from below upwards through the transverse meso-colon. When separation of the spleen is rendered difficult and dangerous because of adhesions John Gerster advises ligation of the splenic artery near its origin. This may be easily accomplished through a hole torn in

FIG. 640.—Control of splenic vessels. (*Mayo.*)

the lesser omentum (Fig. 639). To this must be added ligation of the left gastro-epiploic artery (branch of the splenic) just as it reaches the stomach, because of its being in continuation with the right gastro-epiploic. The left gastro-epiploic artery may be exposed by pulling the stomach and left margin of the great omentum towards the right. "While cessation of the arterial stream does not afford absolute hemostasis, the hemorrhage from the torn veins alone is easier of control and is certainly less than if it came from both arteries and veins." (John Gerster, Journ. A. M. A., Aug. 7, 1915.)

Step 4.—With sutures close all the wounds made in the posterior peritoneum

and if the gastro-splenic omentum was divided separately suture its stump to the posterior abdominal wall.

Step 5.—Close the abdomen.

In Banti's disease (splenic anæmia) Mayo has found not only complete but even partial splenectomy useful. After exposing and pulling the spleen forwards out of its bed, using blunt dissection to form a passage-way around the pedicle, grasp the pedicle with the blades of a suitable clamp (gastro-enterostomy clamp with blades protected by rubber tubing). Complete the separation of the spleen from its connections and deliver it through the abdominal wound. The forceps on the pedicle should be placed as far away from the spleen as possible for obvious reasons (Fig. 640). If partial splenectomy is chosen, cut away as much of the organ as necessary and close the wound with a continuous button-hole suture of catgut introduced with a round needle; loosen the clamp. If hæmorrhage occurs temporarily reapply the clamp and introduce more sutures where they will do most good. If complete splenectomy is chosen the temporary control of the pedicle makes its permanent ligation easy.

Mayo ("Journ. A. M. A," Jan. 1, 1910) notes that "it has been shown experimentally that reduction of the arterial supply by ligation results in atrophy of the spleen and that as long as the veins are left intact necrosis does not occur. If the splenic artery divides in the hilum, ligation of branches would appear to be an active competitor of partial splenectomy. Lanz (quoted by John [illegible]) ligated the splenic artery in the case of a man with a spleen which was [illegible] in the bone pelvis and which was causing severe pain on urination and defecation. Six months later the splenic tumor could not be palpated. [illegible] (La Pr. Med., 30, Sept., 1911) states that "in the four cases where [illegible] ligation has been practised (Battie; Wyman; Tricomi; Küster, the operation was fatal. These failures are explained by the fact that the splenic is a [illegible] artery without anastomosis. The operation might be done by applying the ligature proximal to the short vessels so that a partial circulation might [illegible] established in the spleen by means of the union of the vasa brevia with the [illegible] gastric vessels."

CHAPTER XLII

THE SUPRARENAL BODIES

The suprarenal bodies rest upon the diaphragm opposite the eleventh and twelfth ribs. They are separated from one another by an interval of 2 to 2½ inches. They are situated at the upper and inner border of each kidney, and obtain a rich supply of blood through special arteries from the aorta and through branches of the renal and phrenic arteries. In front of the left suprarenal lies the stomach; to its outer side is the spleen. The right suprarenal "is related in front to both the inferior and posterior surfaces of the right lobe of the liver (impressio suprarenalis); internally to the vena cava, which slightly overlaps it, and its inferior angle is crossed by the first bend of the duodenum. It lies behind the foramen of Winslow." (Woolsey.)

Adrenalectomy.—The surgery of the suprarenal bodies belongs more to the future than the present but even now enough has been done to demand a short notice here.

The most common cause of Addison's disease is tuberculosis of the suprarenal body, and most of the successful operations have been performed in such cases. Usually operation has been undertaken on a diagnosis of "retroperitoneal tumor" or of a tumor affecting the upper pole of the kidney, and these errors in diagnosis are liable to be repeated in the future. An early recognition of suprarenal disease is impossible in our present state of knowledge or ignorance.

The suprarenal bodies may be reached through the lumbar region or through the peritoneum. When the former route is chosen, the incision must be extensive, and exactly like that for nephrectomy. In most cases of adrenalectomy, nephrectomy will be part of the operation, for two reasons: (*a*) because the removal of the kidney renders less difficult an atrociously difficult operation: (*b*) because the kidney is often involved in the disease, especially if that disease is malignant.

Helferich operated through the lumbar route and partially removed a tuberculous suprarenal with complete success (Schede, "Handbuch der praktischen Chir.," iii, 1106). Most operations have been performed by the transperitoneal route. Oestreich diagnosed and Hadra operated upon a pulsating tumor of the suprarenal. When the abdomen was opened in the middle line above the umbilicus, a tumor the size of a hen's egg, of a whitish and yellowish-brown color, was seen through the lesser omentum. This tumor was on and to the left of the aorta, and after excision proved to be a much caseated supra-

renal body. The wound was packed and the patient recovered. In a case operated on by Jonas (Schede, *loc. cit.*) the bronze hue so characteristic of Addison's disease faded in ten days and disappeared in three weeks. There is little prospect of much benefit from operation on malignant tumors of the suprarenals.

CHAPTER XLIII

OPERATIONS UPON THE LIVER

OPERATIONS FOR HEPATOPTOSIS, OR MOBILE OR FLOATING LIVER

Ptosis of the liver may be partial or complete.

Partial ptosis means that a portion of the liver is more or less pushed away or snared off from the rest of the organ as a result of error is dress (tight lacing) or of some disease. Riedel's tongue-shaped lobe, so common in cholelithiasis, is a form of partial ptosis. Occasionally the junction between the aberrant lobe and the rest of the liver is thin, and from irritation, etc., has become sclerosed.

Complete ptosis means that the liver is dislocated *en masse* to a greater or less degree.

(A) **Operations for Partial Hepatoptosis.**—1. *Indirect Operations.*—When the ptosis is in the form of a Riedel lobe and dependent on gall-bladder disease, the latter disease must be treated according to the methods advised in the chapter on Biliary Surgery. Excellent results are thus obtained.

2. *Excision.*—The mobile lobe may be excised. (See "Hepatectomy.")

3. *Ventro-fixation.*—Open the abdomen over the most prominent part of the tumor. Suture the "floating lobe" to the parietes by several thick catgut sutures. Before tying the sutures scarify the surfaces about to be opposed.

4. *Kehr's Operation.*—Kehr, adopting Rydygier's idea in splenopexy, applies it to the fixation of partial hepatoptosis. Make a horseshoe-shaped incision (concavity upwards) around the lower circumference of the mobile lobe down to but *not* through the transversalis fascia. At the lowest point in the wound open the belly by a transverse incision through the transversalis fascia and the peritoneum. Separate the transversalis fascia and the peritoneum, together, from the more superficial structures of the parietes over an area corresponding to the horseshoe-shaped incision. At the upper end of this loosened area make an incision through the fascia and peritoneum parallel to the lower transverse incision. A pocket of fascia and peritoneum is thus formed into which the "floating lobe" or its lower margin may be tucked and secured. Close the wound with sutures.

(B) **Operations for Complete Hepatoptosis.**—(I) *Step* 1.—*Exposure of organ:* This may be accomplished by a vertical incision either in the middle line or along the external border of the right rectus muscle or by a cut parallel to the costal arch. The vertical incisions are the better, and may be supplemented by a transverse cut if such appears necessary.

Step 2.—*Return the liver to its normal position:* If the organ has become

adherent in its faulty location, and adhesions must be separated, unless, of course, they are so extensive that the danger involved in their separation would be out of proportion to the good to be attained by a successful hepatopexy. An assistant supports the liver in its improved position while the surgeon carries out the next step.

Step 3.—*Fixation of the liver by sutures:* Pass coarse catgut or silk sutures through the parenchyma of the anterior edge of the liver, each suture taking a deep hold of the organ, and then make the sutures penetrate between the cartilages of the adjacent ribs. During this procedure the pleura has been injured, but no harm has resulted. The sutures must be thick to avoid cutting the friable organ. In actual practice the number of sutures has varied from two to eight; the more numerous they are, the more is the strain divided and the liability to cut lessened. The hepatic and parietal surfaces which are to be opposed should be scarified before the sutures are tied. Care must be taken, when the sutures are being tied, to avoid cutting the liver substances with the threads. Some surgeons apply a few sutures between the liver and the upper end of the abdominal wound. Lucas Championnière modifies the operation by passing some of the threads through the suspensory ligament.

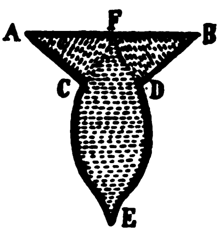


FIG. 641.

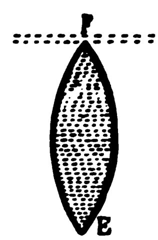


FIG. 642.

FIGS. 641 AND 642.—Depage's laparectomy. (*Monod and Vanverts.*)

If it is impossible to reduce the liver, it may be fixed by suture wherever possible so as to give relief from distressing symptoms.

(II) *Depage's Operation* (*Hepatopexy and Laparectomy*).—Depage considers laxity of the abdominal walls a great factor in the production of hepatoptosis and directs his attention specially towards removal of this condition.

Step 1.—Make the horizontal incision A B (Fig. 641) from the tip of the eleventh rib on one side to the tip of the eleventh rib on the other side. From the point A make an incision A C, downwards and inwards to meet an imaginary line passing horizontally through the umbilicus. The length of the cut A C is equal to one-half the cut A B. From the point B make the incision B D in the same way as A C was made. From the points C and D make curved incisions downwards to near the pubis. The convexity of the curves is outwards. These cuts meet at the point E. Remove all the skin enclosed by the above incisions. Dilatation of the belly has caused the linea alba to become very wide. "Remove the linea alba, including the peritoneum, from the anterior or internal border of one rectus muscle to the internal borders of the other

rectus muscle. Make traction upon the umbilical ligament of the liver and the inferior extremity of the falciform ligament, and, pulling them into the upper angle of the wound, shorten and anchor them there by sutures."

Step 2.—Suture the abdominal wound with extreme care. Depage sutures in planes as follows: (*a*) The peritoneum alone; (*b*) the peritoneum and muscular planes together; (*c*) the muscular plane alone; (*d*) the aponeurotic and muscular planes together; (*e*) the aponeurosis alone; (*f*) the skin and subcutaneous tissue together; (*g*) the skin alone. In suturing, the edge of the wound A C is united to the edge A F; the edge B D to B F, and the edge C E to the edge D E. The resultant scar is T-shaped (Fig. 642).

HEPATECTOMY. EXCISION OF HEPATIC TUMORS, ETC.

As it is self-evident that the liver can never be removed *in toto*, it is useless to prefix the word partial to the title of this section.

The experiments of Ponfick, repeated and supported by other observers, have proved that much liver tissue can be removed without specific injury (three-fourths was removed in animals), and that new liver tissue is formed to take the place of that removed. The great impediment to hepatic surgery has been the fear of hemorrhage. Many methods have been adopted to overcome this real danger. A few of the methods will be described.

I. Exposure of the Tumor.—The abdomen is opened over the tumor by a cut made in any direction which may be convenient or by a combination of cuts. The incision must be large enough to give very free access to the field of operation. The tumor is now examined as to kind and location. It is assumed that the diagnosis is such that radical operation is permissible. If the tumor involves most of the right lobe of the liver, the operation must be at once abandoned, so also if the hilus is much involved. Tumors on the posterior and superior parts of the liver are inaccessible. Tumors of the left lobe and of the anterior margin of the organ may be brought forwards by division of parts of the hepatic ligaments; this permits of partial dislocation of the whole organ. Some surgeons have excised the lower ribs (subperiosteally) and have thus been enabled to retract the diaphragm upwards. When the patient is lying on his back with the posterior hepatic region supported on a sand-bag, it is extraordinary how much of the liver may be brought out through the Mayo-Robson incision (page 561) without any resection of ribs. It is difficult to believe that enough benefit can be attained by rib resection to warrant the extra trauma and risk.

II. Removal of the Tumor.—When peritoneum exists over the tumor and is free from disease, it should be divided and reflected from the surface of the tumor. If the tumor is non-malignant and appears to be fairly well encapsulated, it may often be shelled out of its hepatic bed with but little hemorrhage. When the tumor is very small and situated at the liver margin, it may be removed by a V-shaped incision made with knife, scissors, or thermocautery. While the cut is being made an assistant compressing the neighboring liver

controls bleeding temporarily. When the tumor is attached to the liver by a distant pedicle, the pedicle may be surrounded by an elastic ligature and the tumor removed, or the removal may be accomplished without the aid of the elastic constrictor. In all the above instances bleeding is temporarily controlled while the tumor is being removed. When the tumor is non-encapsulated, non-pedunculated, or involves much of the liver substance, one requires to proceed step by step, stopping bleeding as one goes.

Methods of Hemostasis.—I. During the operation:

(*a*) *Temporary elastic ligature:* A rubber tube thrown around a pedicle permits the surgeon to remove the tumor at his leisure and subsequently take other means to stop the bleeding permanently. When there is no pedicle, it has been advised to pierce the whole thickness of the liver behind the tumor with a cannula, place a *double* elastic ligature through the instrument, and tie the ends of the ligature on each side of the tumor so as to act as a tourniquet.

(*b*) **Pringle's Method.**—Pringle ("Annals Surg.," xlviii, p. 541) has used digital compression of the portal vein at the foramen of Winslow and thus secured good, safe temporary hemostasis. To gain access to wounds of the liver after temporary hemostasis is secured, Pringle thinks well of Langenbuch's suggestion to divide the coronary and right lateral ligaments so as to allow the liver to be dislocated and delivered up to the abdominal wall, or to give more room by dividing some of the lower ribs and turning up a flap of ribs and diaphragm. Willy Meyer has carried out this plan.

(*c*) **McDill's Method.**—McDill ("Journ. A. M. A.," Oct. 5, 1912) compresses the vessels by means of an enterostomy forceps, the blades of which are protected with rubber tubing. After the gall-bladder region is fully exposed in the usual fashion McDill makes a 1-inch skin incision immediately below the costal margin in the right axillary line, tunnels from here through the parietes and introduces the enterostomy clamp through the tunnel (Fig. 643).

(*d*) Auvray recommends applying to the liver around the portion to be removed a series of interlocked ligatures of thick silk or catgut. To apply the ligatures use a blunt pedicle needle with a very long curve. Each individual ligature, after being crossed with its fellow to the right and left, is slowly and steadily tied with such firmness that the liver parenchyma is cut, but the vessels remain undivided in the loop. When the whole series of ligatures is tied, the tumor is removed with cautery, knife, or scissors. It is of importance while transfixing the liver with the needle to use little force, and when any obstacle to the passage of the instrument is encountered, to manipulate the needle from side to side and so gently guide it past the obstruction. Such obstructions are usually large vessels, and any force used might injure them. The points of transfixion should be about one centimeter (3/8 inch) apart. Auvray's researches have been very thorough and successful. The method he advises certainly appeals to one's common sense.

Using practically the same method as Auvray, Cullen has removed a large carcinoma of the liver. He used silver needles straight and curved, exactly the same as Hagedorn's except that they had blunt ends. After the ligatures were

in place he found that the "raw surface could be rolled in upon itself, so that the two halves formed flaps. These were brought together until little or no raw surface remained. The ends of the sutures that had already been tied were utilized to bring the opposite sides together."

Freeman has used with success, for the same purpose and in similar manner narrow strips of gauze. He found much difficulty in removing the gauze because the knots sank into the liver substance, so he now recommends that the ends of gauze be fastened with forceps or catgut instead of being knotted. ("Trans. Am. Surg. Assoc.," 1904.)

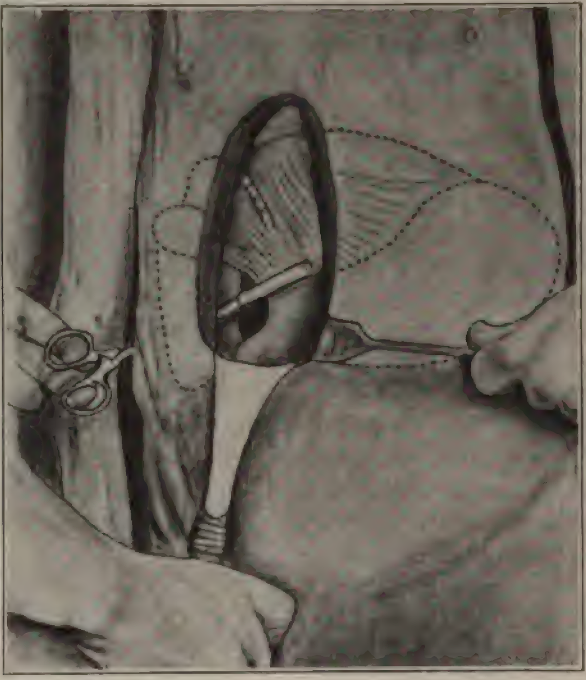


Fig. 643.—(*McDill, Journ. A. M. A.*)

Kornew and Schaack (Zent. für. Chir., 14, June, 1913, page 949) have frequently successfully removed large masses of liver in dogs as follows: Take two broad strips of fascia (obtained from any convenient place on the same patient, *e.g.*, the thigh) and place them on the upper and under surface of the liver just internal to the line of proposed section. With a long rounded needle introduce near the inner edge of the strips of fascia a row of continuous mattress sutures. These sutures are of thick catgut or silk and pass through both the fascial strips and the liver and ought to be applied in the shoemaker fashion. After the sutures are pulled tight they are tied together at the anterior and posterior edge of the liver (Fig. 644. Cut away a portion of liver condemned. Cover the liver stump with the cuff formed by the fascia (Fig. 645).

Auschütz ("Deutschen Gessellsch. für Chir.," 1907) lays down the following rules for resection of the liver:

1. The incision through the liver substance should be made with a sharp knife and the vessels picked up with forceps and ligated. If the hepatic tissue is divided by blunt force the vessels subsequently retract and are difficult to find and secure.

2. When possible the liver wound should be wedge-shaped to permit closure with suture.

3. No special instrument are required for the insertion of deep ligatures in the liver. The ligatures should be tied slowly but firmly.

4. In suitable cases the temporary use of an elastic ligature is valuable.

5. Usually no abdominal tampon is required after suture.

6. Division of the hepatic ligaments is often an aid in resection.

7. When it is necessary to attack the dome of the liver, do not hesitate to resect the right costal arch and to divide the suspensory ligament.

FIG. 644.

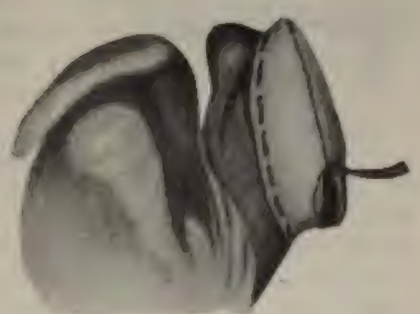


FIG. 645.

FIGS. 644 AND 645.—(*Kornew and Schaack, Zentralblatt für Chirurgie.*)

Garrè uses catgut No. 2 for deep sutures which go through the whole thickness of the liver, while for serous sutures and for the ligation of individual vessels on the cut surface of the liver he uses extremely fine silk. He does not treat the stump extraperitoneally, has not lost a single case and has penetrated the liver substance to the extent of fully 5 inches (10 to 14 cm.).

(*e*) *Thermocautery:* Many surgeons use the thermocautery instead of the knife when dividing liver. While the cautery does not control bleeding from the larger vessels, it certainly does control oozing. The cautery ought always to be ready when hepatic incisions are made, since it may be found useful, at least as an aid to other methods.

(*f*) *Ligature:* The ligation of hepatic vessels is often difficult, their walls being thin and delicate. Frequently direct ligation of the vessels is impossible. When this is the case, one may, with a curved needle, pass a suture around

the vessel, and on gently tying it the bleeding ceases. To this suture-ligature the Germans give the name "Umstechung."

The above are the principal means of hemostasis used during the operation.

II. The methods of securing hemostasis after the operation are practically the same as the methods of treating the stump.

(A) *Intraperitoneal.*—The liver wound, having been closed by suture or ligature, or charred by the thermocautery, is allowed to drop back in the belly. If peritoneal flaps were dissected back from over the tumor, they are replaced and sutured together. Place a strip of gauze under the liver and against the liver wound; bring the end of this strip out through the abdominal wound. Close the excess of wound.

(B) *Extraperitoneal.*—The tumor is delivered through the abdominal wall. The pedicle is compressed by an elastic ligature. The tumor is cut away. The stump is fixed to the abdominal wall by sutures or by pedicle pins. The elastic ligature is left *in situ.* The dangers of this method are, first, that the sutures or pins fixing the liver to the abdominal wall are very liable to cut through the friable liver substance; and, second, that the risks of infection through the stump are very real. Some surgeons have performed the operation in two stages. At the first sitting the liver is attached to the belly-wall. Only after adhesions have formed is the tumor removed. When applicable, this may be a good method.

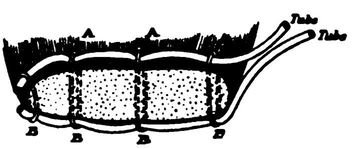


FIG. 646.—Hemostasis liver.

(C) The pedicle is treated as in A, but the liver wound is walled off from the rest of the peritoneal cavity by means of gauze packs and a tampon of gauze is pressed against the wound itself. The ends of the pieces of gauze used for pack and tampon are brought out through the abdominal wound.

Undoubtedly the best way to treat the stump where possible is by a combination of suture and packing. The surface of the pack facing the abdominal cavity should be covered by rubber tissue. The ends of the catgut sutures applied to the liver should be left long and tied over the pack so as to keep the latter in place. (See "Cholecystectomy.")

To exert hemostatic pressure upon the liver and to prevent the cutting of the parenchyma by sutures one rubber tube may be laid on the upper surface of the liver, another on the lower surface. Thick catgut sutures (A, B, Fig. 646) penetrating the liver are fastened to the tubes. The ends of the tubes are brought out of the wound and are to be removed when they have served their purpose. Instead of rubber tubes, plates of decalcified bone and of various materials have been employed.

Kocher has applied his large stomach clamp to the liver with force, crushing through the parenchyma and excising the portion of liver distal to the clamp. He leaves the clamp *in situ* for forty-eight hours.

Van Buren Knott has successfully removed a primary sarcoma from the anterior border of the liver (the tumor was pedunculated and weighed over

one pound) using rubber-covered clamps which he left *in situ*. The operation was difficult because of adhesions and the patient was much debilitated.

Stuckey ("Archiv. für klin. Chir.," xcix, 384) in cases of hemorrhage from the liver after cystectomy has found that he could stop the bleeding as follows: Pick up a terminal segment of omentum of suitable size, ligate and excise it. Cover the liver wound with the excised (free) flap of omentum and hold it in position by gauze pressure for a short time. Very quickly the omentum adheres to the liver wound and stops the bleeding. A gauze pack may be used to hold the graft in position as an extra precaution.

ABSCESS OF THE LIVER

Aspiration.—Aspiration as a method of treatment for liver abscess is not to be recommended. It has its sphere of usefulness as a means of diagnosis, but its use is not without danger.

The skin is cleaned over the most prominent or most tender part of the swelling, usually the ninth or tenth interspace vertically below the angle of the scapula, and the sterilized aspirating needle is inserted in various directions until pus is found. Greig Smith remarks that "the movements of the needle, following the movements of the liver (if it moves with respiration), must not be checked, as thereby the liver tissue may be torn and permit escape of pus into the peritoneum."

Hepatotomy.—(A) *Abdominal Route.*—The object of operation is to expose the enlarged liver; to examine it; to incise and evacuate the contained pus without soiling the general peritoneal cavity. An incision four to five inches in length is made over the most prominent part of the swelling. This incision is usually longitudinal. The belly is opened and the liver examined. If the liver is found adherent to the parietes opposite the wound these adhesions ought to be preserved, as the avoidance of peritoneal contamination is rendered easier by their presence. When a sufficiency of adhesions is not present, the portion of liver about to be attacked is carefully isolated from the peritoneum by pads of gauze. Unless the exact location of the abscess is very evident, an aspirating needle is passed into the liver until pus is found. The needle being held in place, a knife or the blade of a cautery is inserted into the abscess, guided by being kept in contact with the needle. The needle is withdrawn. The forefinger is pushed into the abscess along the side of the knife, which is now taken out. The abscess cavity is explored digitally and any signs of a second abscess noted. If such exists, it may be opened from the first cavity by the finger or a closed hemostat being pushed into it. The abscess cavity is now carefully douched with hot water, a rubber drainage-tube is inserted to its deepest part, and the rest of the cavity loosely filled with midly iodoformized gauze. The pads of gauze which have protected the peritoneal cavity are removed and the neighboring peritoneum is mopped clean and dry. Smith recommends that the whole length of the incision in the liver be sutured to the abdominal wound. This may be done with very

coarse catgut or silk sutures. Coarse sutures are necessary, as fine ones would cut through the liver substance. Any of the abdominal wound unoccupied by attached liver is closed by sutures. Abundant absorbent dressings are applied and the patient put to bed.

According to the amount of discharge the wound will require dressing at more or less frequent intervals. The outer dressings, *i.e.*, those down to the drainage-tube, will probably require to be changed in a few hours. Unless demanded by the condition of the patient, the packing of iodoform gauze filling the abscess cavity ought not to be changed before twenty-four or forty-eight hours after operation. When the packing is withdrawn, if necessary, the abscess cavity may be gently douched with hot water. This is best accomplished by attaching a soft-rubber catheter to the tube of an irrigator and passing it into the deepest part of the cavity. Thorough and gentle lavage is thus insured. The irrigator ought not to be elevated much more than two feet. After washing, the cavity is once more loosely filled with mildly iodoformized gauze and the dressings applied. In all such cases iodoform is better than plain gauze, but the iodoform ought to be in small quantity, as absorption is liable to be great in such an organ as the liver.

(B) *Transpleural or Thoracic Route.*—When the abscess is situated far back on the dorsum of the liver, evacuation by the abdominal route is inapplicable. By the time that a hepatic abscess has become large enough to be diagnosed and its position ascertained, there is almost always adhesive pleuritis present; the liver is adherent to the diaphragm, and the diaphragmatic pleura to the parietal, so that a safe route exists to the pus via the obliterated portion of the pleural cavity.

The Operation.—Place the patient on his sound side. Demonstrate the presence and location of the pus by the aspirating needle introduced through the ninth or tenth intercostal space vertically below the angle of the scapula. Make an incision about three or four inches in length along the rib immediately below the aspirating needle. Excise about two inches of this rib, subperiosteally. As a rule, the site of the excised rib is below the pleura or this portion of pleura is obliterated. If the pleural cavity is opened by accident or design, it must be at once protected (*a*) by the insertion of a few catgut stitches to close the cavity, (*b*) by applying a pack of gauze. This gauze pack may well be held in place by a few stitches of fine plain catgut. By the time it is safe to remove the gauze the catgut will have been absorbed. The diaphragm lies exposed; seize it with forceps and incise it. This exposes the liver, usually adherent to the diaphragm. The aspirating needle still *in situ* forms a guide to the abscess, which must be evacuated as described in the preceding paragraphs.

Choice of Operation.—Many surgeons consider the thoracic route the preferable. When sufficient adhesions are present, it undoubedly is exceedingly safe, but, on the whole, the abdominal route is the better. More cases of liver abscess can be reached through the abdomen than through the chest, and, while a satisfactory examination of the liver for secondary and

complicating disease is possible, the dreaded increased danger from possible soiling of the peritoneum can be practically completely averted by suitable packing with gauze.

SUBPHRENIC ABSCESS

Subphrenic abscess is commonly a sequel of perforative gastric ulcer, of appendicitis, and of hepatic abscess; its treatment may be merely an extension of the treatment of the primary disease. The treatment, of course, consists in evacuating the pus and in securing efficient drainage. The pus is reached in practically the same manner as is that in a hepatic abscess, and the methods require no special description. Counter-openings for drainage may be necessary.

CHAPTER XLIV

OPERATIONS ON THE BILIARY PASSAGES

Operations on the gall-bladder and bile-ducts are most commonly required because of the presence of gall-stones or of infective processes.

Preparation of the Patient.—The preparation for the operation is identical with that for almost any other abdominal operation, but when chronic jaundice is present, calcium chloride should be administered by the mouth in thirty-grain (gr. xxx) doses for two or three days prior to the operation, and in sixty-grain (gr. lx) doses per rectum for a few days thereafter (Mayo Robson). This rather heroic exhibition of calcium chloride is the great preventive of the hemorrhage which is so often fatal after operations on the jaundiced. All cases of obstruction due to stone in the common duct, in which purpuric spots

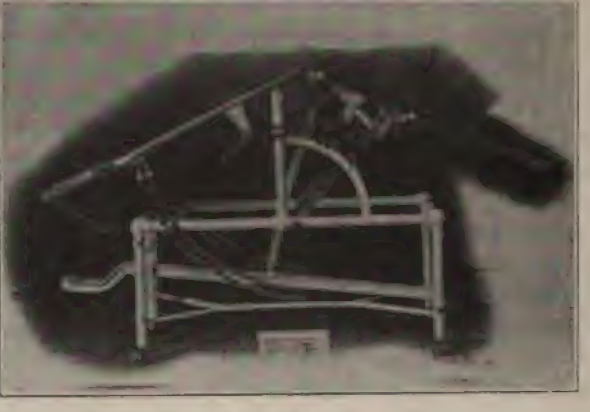


FIG. 647.

are present in the skin, die from hemorrhage if operated upon. Some of these cases when treated with calcium chloride improve sufficiently for operation to become justifiable.

Position of the Patient.—Place the patient on his back and suport the region of the liver on a firm sand-bag 18 inches long, 6 inches wide, and 3½ inches deep. This opens the costal angle and makes the intestines gravitate from the field of operation; it also pushes "the spine forwards, and with it the liver and bile-ducts, so that the common and hepatic ducts are brought several inches nearer to the surface." (Robson.) This position (Robson's) is conveniently obtained without the use of a sand-bag on the table shown in Fig. 647.

Methods of Exposure of the Gall-bladder and Ducts.—Very many incisions have been advocated and used.

Method A.—McArthur's incision: Make a vertical incision through the rectus over the gall-bladder. Retract the edges of the muscle wound. Note the aponeurosis of the transversalis muscle with some of its muscle fibres running transversely in the posterior rectus sheath. Divide the posterior rectus sheath transversely to the long axis of the body. This wound is easily and securely closed and gives sufficient access in easy cases of cholecystostomy. If more room is required the wound may be converted into a Bevan incision.

Method B.—Mayo Robson's incision: Make a vertical incision over the middle of the right rectus muscle. Separate the fibres of the muscle with the fingers or the handle of a scalpel. Divide the posterior sheath of the rectus and the peritoneum together. This incision is two to three inches in length. When it is necessary to explore the hepatic, common, or deeper portion of the cystic ducts, continue the original incision *upwards* as far as possible in the space between the ensiform cartilage and the right costal margin following the costal margin (Fig. 648). The incision is similar to the upper part of Bevan's incision. It freely exposes the upper surface of the liver. Lift the lower border of the liver in bulk (if necessary, drawing the organ downwards from under cover of the ribs), thus bringing the whole of the gall-bladder and the cystic and common ducts quite close to the surface. As the gall-bladder is usually strong enough, let the assistant take hold of it with his fingers or forceps and by gentle traction keep the parts well exposed, while at the same time he protects and retracts, with a sponge in his left hand, the left side of the wound and the viscera, which would otherwise obstruct the view. "It will now be observed that instead of the gall-bladder and cystic duct making a considerable angle with the common duct, an almost straight passage is found from the fundus of the gall-bladder to the entrance of the bile-duct into the duodenum, and if adhesions have been thoroughly separated, the surgeon has immediately under his eye the whole length of the ducts with the head of the pancreas and the duodenum. (Robson, "Brit. Med. Jour.," January 24, 1903).

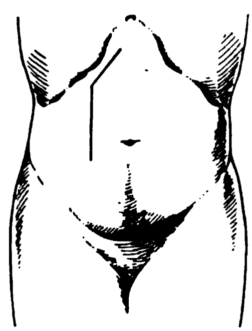


FIG. 648.—Mayo-Robson's incision.

Method C.—Bevan's incision: Bevan criticizes the vertical incision in the right semilunar line as being insufficient, and when long, objectionable because of nerve destruction; a T-shaped incision is difficult to close and is liable to lead to hernia; median incision does not give free access to the gall-bladder. He advocates the following method ("Annals of Surgery," xxx, 17): Make a vertical incision along the outer border of the right rectus muscle or between its outer fibres. This suffices for the exploration or the completion of a simple cystostomy. If it seems necessary to expose or work on the ducts, enlarge the incision by continuing its upper end obliquely upwards and inwards, its lower end obliquely downwards and outwards.

Method D.—Kehr's incision: From the ensiform process make a cut in the

middle line downwards for about 1½ inches; then divide the right rectus obliquely and continue the cut downwards in the semilunar line.

Method E.—Kocher's oblique incision: Make an incision four inches in length parallel to and about two inches below the right rib margin. This incision divides the outer fibres of the rectus muscle and portions of both the internal and external oblique. Branches of the intercostal nerves run across the incision towards the rectus, and these must be retracted downwards or upwards and preserved uninjured. Kocher's incision gives very free access to the biliary region, but necessitates an undue amount of muscle injury.

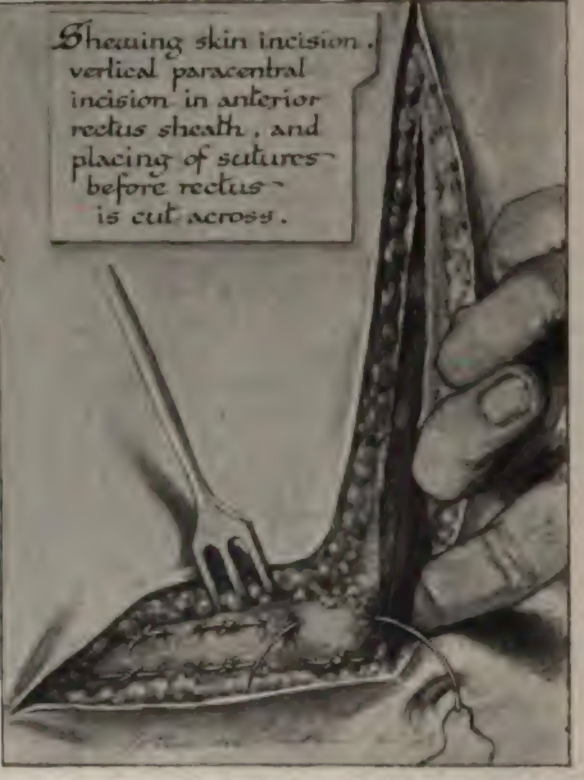


FIG. 649.—(*Gray*, by permission from the *British Journal of Surgery*.)

Kocher also uses an incision which passes in the middle line from near the ensiform cartilage to near the umbilicus and thence outwards through the rectus muscle. Pannett modifies this cut as follows: "A long paramedian rectus sheath incision is made from about 1 inch below the ensiform cartilage to the umbilicus, and the abdomen opened in the usual way. Exploration is then made to ascertain whether exposure is adequate. If it is not, the anterior rectus sheath is separated from the muscle and pulled outwards. The rectus itself is divided part of the way across, at a point midway between the ensiform

cartilage and the umbilicus. . . . . With adequate retraction such an incision gives ample room . . . ."

Method F.—Fritz König's incision: F. König thinks that high epigastric incisions affect respiration unfavorably. Beginning not less than three finger-breadths below the ensiform cartilage make a median incision downwards for ¾ to 1½ inches then curve the cut transversely across the right rectus muscle to its external margin. It is always possible to avoid injuring the nerves. The location of the transverse part of the incision depends on how low the liver and gall-bladder lie. Perthes' incision is very similar but has some distinctive

FIG. 650.—(*Gray*, by permission from the *British Journal of Surgery.*)

features. H. M. W. Gray endorses its value. (Brit. J. of Surg., I, page 200.) Make a vertical incision through the right rectus close to the middle line from the ensiform to the umbilicus. From the lower end of this incision cut horizontally outwards, through the skin and subcutaneous tissues, to near the costal margin. With two rows of sutures unite the aponeurosis to the rectus muscle (Fig. 649). Divide the rectus transversely and reflect it upwards, and outwards as a flap with the skin (Fig. 650). Divide the posterior sheath of the rectus and the peritoneum obliquely near the base of the muscular flap. The vascular and nerve supply of the rectus is well protected.

Method G.—Sprengel's incision: Oblique section of the right rectus parallel to the costal arch. If more room is required make a short incision upwards and outwards at the outer end of the wound and split the fibres of the external oblique. Retract the edges of the wound in the external oblique and separate the fibres of the internal and transversalis. If the common duct requires exposure extend the incision so as to partially or completely divide the left rectus.

Method H.—Rutherford Morison's incision: Make a transverse incision from the ileo-costal space behind to the outer edge of the rectus in front. Besides giving free access to the gall-bladder and ducts this permits of easy posterior drainage.

EXAMINATION OR EXPLORATION OF THE GALL-BLADDER AND BILE-DUCTS

When the abdomen is opened, the gall-bladder is usually easily recognized, and it is easy to palpate this viscus, to follow the cystic duct downwards, and, by passing the finger through the foramen of Winslow, to palpate at least the supra-duodenal portion of the common duct. Often the gall-bladder is hidden in a mass of adherent omentum or other viscera, or it may be much shrunken as well. Under these circumstances, beginning at the liver margin, separate the adhesions. Use the liver as a guide to the site of the gall-bladder. Many of the adhesions may be separated by the fingers, but many must be cut between ligatures. The separation of adhesions must be accomplished with much circumspection, as nature occasionally herself performs the operation of cholecystenterostomy, and when this is the case, the surgeon is liable to penetrate the junction between the gall-bladder and the gut. When this accident occurs, the hole in the gut must at once be closed by a double line of sutures. When the gall-bladder is much shrunken, the search for it makes a severe call on the patience of the surgeon. When the gall-bladder is distended or not shrunken, it is easy to pull it up into the wound. Before breaking down adhesions around the biliary passages be careful to protect thoroughly the peritoneal cavity by means of suitable pads or sponges. When freeing the gall-bladder and the ducts from surrounding adhesions, one is liable at any moment to open into some collection of infective material, and dangers from this source must be guarded against. As was hinted when describing Robson's incision, it is of first-rate importance to free the bile-ducts from surrounding adhesions; if this is not done, the exploration becomes a sham. The guide to the common duct is the gall-bladder and cystic duct.

OPERATIONS ON THE GALL-BLADDER AND DUCTS

Ideal Cholecystotomy.—This operation consists in opening the gall-bladder, removing any stones which it may contain, and closing the wound by two layers of sutures exactly as one would close a wound in the small intestine. Bernays has advocated this procedure and called it ideal. Vautrin carried

out a similar operation, but sutured the closed viscus to the upper part of the abdominal incision (cholecystopexy). Union of the gall-bladder to the upper part of the wound has the advantage that, the fundus being fixed in an elevated position, natural drainage of the viscus is aided. Cholecystotomy is rarely, if ever, indicated, since to be justifiable it presupposes a practically normal gall-bladder.*

Cholecystostomy.—Cholecystostomy is an operation which creates a fistula between the gall-bladder and the parietes. It may be executed in either one or two sittings, usually in one.

Cholecystostomy in Two Sittings.—First sitting: Expose and explore the gall-bladder and ducts. Bring the fundus of the gall-bladder into the upper part of the abdominal wound and suture it to the peritoneum and deepest layer of fascia (transversalis fascia), but *not* to the skin. It is *said* that the sutures ought not to penetrate into the cavity of the viscus, but should merely include a portion of the thickness of its wall (serous and muscular, not mucous, coats). Close the rest of the abdominal wound with sutures. It is well to attach a long silk suture to the exposed portion of the fundus of the gall-bladder, to act as a guide when the viscus is opened at a later date.

FIG. 651.—Finneys' block tin scoop.

Second sitting: In a few days, when adhesions have formed between the gall-bladder and the abdominal wall, make an opening with a knife into the gall-bladder and so establish the fistula.

This operation is eminently safe and was a great aid in establishing the surgery of this region, but to-day the operation in one sitting has become practically as safe and has the incomparable advantage that it permits the finger on the outside of the gall-bladder to assist in the extraction of calculi and in exploration. When the finger cannot enter the abdominal cavity outside the gall-bladder, the extraction of *all* the calculi present becomes a matter of extreme uncertainty. The 'two stage' operation is obsolete.

Cholecystostomy in One Sitting.—Expose and explore the gall-bladder and ducts. Separate all adhesions which impede the work. Thoroughly protect the belly cavity with gauze pads. If the gall-bladder is sufficiently large, pull it up into the abdominal wound. Seize the fundus with two small volsella.

If the organ is tensely filled with fluid, it is usually advised to empty it by means of an aspirator. When the contents are thick, and they usually are so, a small aspirating needle is useless, and a large needle puncture, it seems to the writer, possesses no advantages over a cut. The advantage of aspiration is avoidance of soiling the wound.

Make a small incision into the viscus. Mop away all fluid which escapes. Enlarge the opening. Remove with the scoop (Fig. 651) any calculi which

* In a personal communication Mr. Rutherford Morison informs the writer that he performs cholecystotomy frequently and he has had no cause to regret it.

may be present in the bladder or adjacent portion of cystic duct. A finger outside the gall-bladder greatly aids. Often stones lying in the cystic and rarely the common ducts may be coaxed by the finger (outside the bladder) up into the bladder and so removed. Too much time must not be expended in trying to coax such stones into the bladder, as other and surer means of extracting them are available. Once more explore the interior of the gall-bladder with the finger. When exploring the gall-bladder after it has been opened, much information may be obtained by palpating with a finger of one hand inside the viscus and the fingers of the other hand outside it, but inside the belly. Occasionally one finds the gall-bladder *apparently* divided into two cavities, both containing calculi. The septa between such cavities require division before the stones can be removed. The methods of establishing a temporary fistula into the gall-bladder have undergone a number of changes. The edges of the wound in the viscus were at first sutured to the skin, later to the aponeurosis or to the peritoneum. The resulting fistula was almost always slow, and sometimes failed to close; hence surgeons sought to invert the edges of the gall-bladder wound so that on removal of the drainage tube, which was and is always used, peritoneal surfaces would be left in contact and healing be rapid. W. D. Jones devised a suture for inverting the edges of the gall-bladder wound and attaching it to the parietes. He pulled the viscus well out of the abdomen and sutured it to the parietal peritoneum at a distance from the wound in it (Fig. 654). He next passed a catgut suture through the abdominal aponeuroses and muscles into the gall-bladder near the line of stitches already in place; with this catgut suture he caught up the edges of the wound in the gall-bladder and brought it out through the parietes in the reverse direction to that in which it was introduced. When several such sutures have been inserted and tied the cystostomy wound is properly inverted.

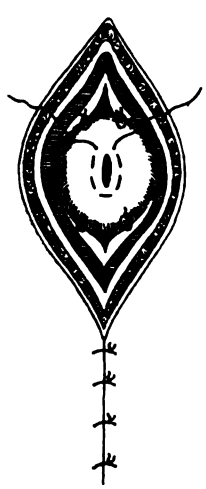


FIG. 652.

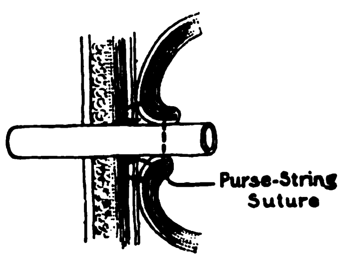


FIG. 653.

FIGS. 652 AND 653.—Cholecystostomy.

J. E. Summers' method of securing inversion and suspension is sufficiently shown in Figs. 652, 653.

The Mayos attained the same end as follows: Prepare a drainage-tube by surrounding it with a few layers of gauze covered by rubber tissue. The

end of the tube should be bevelled or trimmed in the "fish-tail" fashion. Introduce this "dressed tube" a short distance into the gall-bladder. With plain catgut suture the edges of the gall-bladder wound snugly to the tube. Push the tube a little further into the gall-bladder, thus inverting that portion of the gall-bladder around the tube and the original line of suture. With a Lembert suture of catgut attach the surface of the gall-bladder all around the tube to the tube. Leave the ends of this last suture long, and with a needle attach them to the parietal peritoneum.

The advantages of this procedure are: (*a*) The purse-string suture prevents leakage of bile around the drainage-tube. (*b*) When the tube is withdrawn, the inversion of the bladder wound leaves serous surfaces in contact, there is no prolapse of mucous membrane, and hence closure of the fistula is hastened. When numerous small calculi and much biliary "sand" have been removed, it is wise *not* to invert the edges of the wound in the gall-bladder, since by so doing

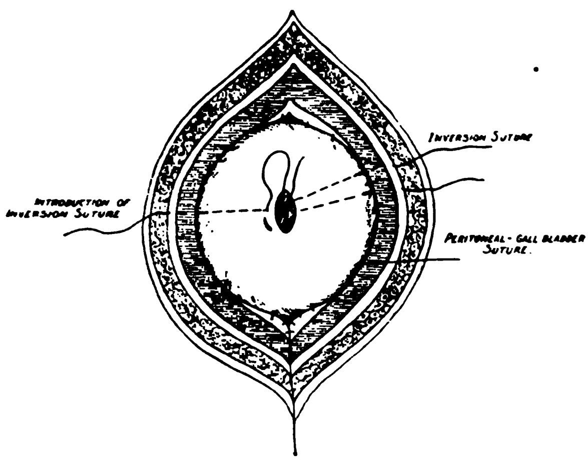


Fig. 654.—Jones' cholecytostomy.

a trap is formed which will prevent the discharge of any "sand" or small stones which may have been overlooked.

When the gall-bladder could not be brought, without tension, into contact with the parietes it was found that if the tube was well sutured into the viscus the latter could be safely dropped back into the abdomen and the tube brought out through the parietes exactly as is done in drainage of the cystic or common ducts. As a precautionary measure it may be well to surround the tube, in its passage through the peritoneal cavity, with a little gauze protected by rubber tissue. This precaution is probably entirely unnecessary as the omentum, that most efficient "abdominal policeman," will certainly surround and isolate the tube. At present the best method of performing cholecystostomy seems to be: (*a*) Evacuate the contents of the gall-bladder by aspiration, incision or both. (*b*) Surround the cystotomy wound by a continuous catgut suture penetrating the coats of the viscus. Introduce a "dressed tube" into the gall-bladder and

tie the catgut suture, already in place, snugly around it. Introduce a purse-string suture of catgut, in the Lembert fashion, into the walls of the gall-bladder, around and a short distance away from the tube. Push the tube farther into the gall-bladder thus causing invertion of the original line of suture. Tighten and tie the purse-string suture. With a needle make the purse-string suture take one or two bites in the drainage tube to anchor the latter. Instead of a "dressed tube" one may use a rubber tube, the end of which has been turned back on itself twice in a double revere. If this tube is used the purse-string suture snugly tied round it just above the revere, which is in the bladder, will prevent it escaping (Fig. 655). (3) Permit the gall-bladder to assume whatever position it pleases, in the abdomen. Bring the end of the drainage tube out through the parietes. (4) Close the abdominal wound with or without further drainage. The tube may be removed whenever it becomes loose.

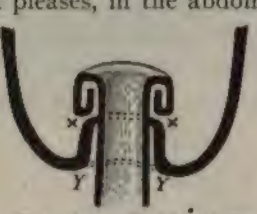


FIG. 655.—Rubber tube with a double revere introduced into gall-bladder.
X–X, Suture around wound in gall-bladder; Y–Y, purse-string suture.

Cholecystectomy.—Is called for under several conditions such as the presence of neoplasms, lithiasis, and inflammation, but the indications necessitating it will be discussed later.

Step 1.—Exposure and exploration of the gall-bladder and ducts.

Step 2.—Aspiration or incision of the gall-bladder is necessary under the following circumstances (Monod and Vanverts): (1) When the viscus is so distended that it is liable to rupture during the necessary manipulations. (2) When external exploration of the common duct leaves doubt as to its permeability and one desires to catheterize the ducts through the bladder. One must remember, however, that the valvular construction of the upper part of the cystic duct does not lend itself to easy catheterization.

In the absence of the above conditions it is better not to open the viscus and thus avoid possible contamination of the wound.

Step 3.—When, as exceptionally happens, the gall-bladder is provided with a "meson," divide this between ligatures or forceps. As a rule, the viscus is applied directly to the undersurface of the liver and held there by the peritoneum, and one operates as follows: Incise the peritoneal covering of the gall-bladder and by blunt dissection separate the organ from the liver. Bleeding from the liver may be controlled by suture, by the use of the Paquelin cautery, or by the sponge pressure. Isolate and ligate the cystic branches of the hepatic artery; ligate and divide the cystic duct. If it is desired to drain the biliary passages, only one ligature or clamp may be applied between the gall-bladder and the point of section of the duct; if complete closure of the passage is sought, then the duct should be divided between two ligatures. Riedel under the latter circumstances closes the abdominal wound without drainage, but most surgeons prefer to drain with a small roll of rubber tissue or dental dam. The peritoneal flaps left after removing the gall-bladder ought to be sutured. If drainage of the duct is required or desired, leave the stump of the duct open

and suture over it or to it a rubber drainage-tube with a stitch of fine plain catgut. This stitch will be absorbed before it is time to remove the tube, and in the meantime will hold it in place.

Undoubtedly cholecystectomy is best accomplished from below upwards—*i.e.*, beginning by dividing the duct. There are two principal reasons for this: (*a*) The dissection is easier; (*b*) the cystic artery (generally two branches) is ligated at the same time as the duct and thus hemorrhage is completely con-

FIG. 656.—(*Judd, Annals of Surgery.*)

trolled at the earliest possible moment. The only objection to this method of removal is that the operator may fear mistaking the common for the cystic duct.

The Operation.—Step 1.—Expose the gall-bladder by any convenient incision; the author prefers one more or less transverse. E. S. Judd writes: "The abdominal incision, instead of being made over the normal location of the gall-bladder, is made high and close to the mid-line, usually extending to the ensiform. Through this high incision, in most cases, much of the right lobe of the liver can be rolled out by using the gall-bladder as a tractor. If the liver

is adherent to the parietal peritoneum, the adhesions should be freed before proceeding further, as the operation is much simpler if the liver can be displaced."

Step 2.—Explore the common duct, the head of the pancreas and the neighboring lymphatic glands. The dissection necessary for this exploration exposes the cystic duct.

FIG. 657.—(*Judd, Annals of Surgery.*)

Step 3.—Apply a forceps to the fundus of the gall-bladder and gently pull it forwards and upwards. Apply a second forceps to the neck of the viscus; traction on this pulls the cystic duct away from the liver. By blunt dissection clear away any fatty and œdematous tissue which obscures the duct. Using the cystic duct as a guide expose its junction with the common duct. "The neck of the gall-bladder and the lowest part of the body of the gall-bladder

frequently lie along side the cystic duct, so that when this is dissected out and pulled up, the cystic duct is easily separated from the surface of the liver (Fig. 656)."

Step 4.—Isolate the cystic duct and the cystic artery *together* for about ½ or 1 inch and doubly clamp them together. Divide between the clamps.

Step 5.—Make traction on the forceps applied to the cystic duct beside the gall-bladder and so make prominent the peritoneal folds attaching the bladder to the liver as well as the communicating vessels which are now easily controlled. Dissect the gall-bladder from the liver, leaving however enough of

FIG. 658.—(*Judd, Annals of Surgery.*)

its fundus attached so that it can be used as a tractor during the next step of the operation (Fig. 657).

Step 6.—Ligate the stump. This can be done without tension and without danger to the common duct because of the thorough dissection. Suture the cut edges of the peritoneal folds from beside the stump up to the edge of the liver, removing the gall-bladder little by little as the sutures are being inserted. Place a small cigarette drain or roll of rubber dam down to the stump of the

cystic duct and along the fissure from which the gall-bladder was removed (Fig. 658).

Cholecystenterostomy.—When the common duct is irreparably occluded, *e.g.*, by malignant disease, or when it is desirable to drain the ducts in chronic pancreatitis, the formation of a fistula between the gall-bladder and the gut permits the escape of bile. This operation is cholecystenterostomy.

(A) *Antero-colic method.* When possible, it is best to unite the gall-bladder to the duodenum but under stress of circumstances that portion of the intestine (even the colon) which is most readily brought up against the gall-bladder is the best portion to use. The operation itself is practically identical with that of entero-enterostomy (intestinal anastomosis) and requires no special description. It may be accomplished by the method of suture, by McGraw's elastic suture, or by the Murphy button. Probably the oldest patient ever submitted to this operation was a woman eighty years of age, in whom the author successfully used the Murphy button. Before the operation of choledochotomy was as safe as it is to-day, cholecystenterostomy was much more frequently resorted to than at present; it averted the evils from obstruction of the common duct by stones, but it did not rid the patient of the obstruction itself or of the late effects of the irritation from the obstructing calculus.

When the gall-bladder is anastomosed to a segment of small intestine, it has been suggested that an anastomosis between the afferent and efferent segments of the gut would prevent all possibility of intestinal contents gaining, access to the gall-bladder. This precaution seems, to the author, superfluous, as it would not prevent the passage of the ever-present infection from the intestine into the gall-bladder, even if it did keep the gross contents of the intestine from entrance into that viscus. The increased danger of the extra operation seems out of proportion to the benefit to be obtained.

(B) *Retro-colic Method.* (Brentano, "Zentralblatt für Chir.," 1907, No. 24. Lotheisen, *idem.*, No. 31.)

Step 1.—Open the abdomen. Explore the gall-bladder and ducts.

Step 2.—Pull the transverse colon and great omentum out of the wound and turn them upwards exactly as in posterior gastro-enterostomy. Find the duodeno-jejunal junction; select a portion of jejunum about 12 inches below the junction; select a bloodless portion of the transverse mesocolon close to the gall-bladder and tear a hole in it as in gastro-enterostomy. Pull the selected loop of jejunum, from below upwards throught the rent in the mesocolon. Apply an intestinal clamp (*e.g.*, Doyen's) to the jejunum. Return the colon and omentum into the belly.

Step 3.—If the gall-bladder is distended empty it by means of a trocar and cannula introduced at its dome. Close the puncture.

Step 4.—Choose a suitable portion of the undersurface of the gall-bladder and to it apply an intestinal clamp. Lay the clamped loop of jejunum against the clamped loop of gall-bladder and make an anastomosis. If the Murphy button is used it is unnecessary to clamp the gall-bladder.

Step 5.—Once more pull the colon and omentum upwards so as to expose

he transverse mesocolon. Pull the jejunum downwards until the line of the nastomosis becomes visible below the rent in the mesocolon. With a few titches tack the edges of the rent in the mesocolon to the line of anastomosis. Return the colon and omentum to the abdomen.

No argument is necessary to show the superiority of the retrocolic method of cholecystenterostomy over the older method.

Cysticotomy—Incision into the Cystic Duct.—When calculi are present in the cystic duct, it is often possible to extract them through the gall-bladder. If this is not easy to accomplish, one should not waste much time in such endeavors, but should carefully locate the stones, incise the duct longitudinally over them, and extract them. The wound in the duct may be closed by sutures. The sutures, if of silk or hemp, must not penetrate the mucosa lest they form the nuclei of more calculi. Catgut sutures are excellent and have not this disadvantage. Many surgeons insert but do not tie the sutures before the stones are removed. The suturing is not so difficult as might be imagined, because from disease the ducts are dilated and their walls thickened. It is important to remember that not much time should be devoted to attempts at suturing (the writer has seen death result from such waste of time), since really quite as good results are obtained by drainage of the unsutured passages. The Mayo's suggestion of suturing (with plain catgut) a rubber drain to the open duct and surrounding this with a gauze pack is a most excellent practice, and is eminently safe. On the whole, the inexperienced operator is advised to avoid attempts at suturing the ducts; the Robsons of our profession require no advice, and are marvelously deft with the needle.

Instead of making a separate incision into the duct one may follow Delagenière's plan of continuing the incision, already existing in the gall-bladder, downwards so as to split the cystic duct until the stone is exposed. If necessary the whole length of the duct may be split in the above fashion. Terrier, Hartmann and others, when dealing with stones in the *common* duct, split the gall-bladder, cystic duct and as much of the common duct as may be necessary to expose and remove the stone, after which they remove the gall-bladder, pass a rubber drain far up the hepatic duct (Kehr's "hepaticus drainage") and pack a little gauze around the tube. The tube and pack are brought out of the abdominal wound, the excess of which is closed. It is a wise precaution to anchor the drain and pack to the ducts by fine catgut sutures.

The advantages of splitting the gall-bladder and ducts are that they form an infallible guide to the stone and the wide opening permits of very free exploration. The disadvantages are the difficulty of doing the work when many adhesions are present, and the extent of the wound inflicted. On several occasions the author has found the procedure very useful.

Choledochotomy—Incision into the Common Bile-duct.—The common bile-duct may be considered as consisting of two parts: one, supraduodenal, reaching from the junction of the cystic and hepatic ducts to the union of first and second segments of the duodenum; the other part, retroduodenal, reaching the remainder of the distance to the ampulla of Vater.

The supraduodenal portion of the choledochus is about 3/4 to 1 inch in length and occupies the right margin of the gastro-hepatic omentum. To the left and behind the duct lies the portal vein—further to the left is the hepatic artery. When the duct is dilated by disease, the portal vein may lie in front of it. The dangers from this source have been grossly exaggerated. In operations the portal vein and hepatic artery are rarely seen. The line for safe incision is along the anterior and right side of the duct. The foramen of Winslow is the guide to the duct. A finger passed into the foramen and hooked forwards inevitably brings the duct forwards also. Unfortunately, the foramen of Winslow is sometimes hidden or obliterated by adhesions. Several lymphatic glands exist in the gastro-hepatic omentum, and when enlarged may lead to error. The retroduodenal portion of the choledochus runs for a distance of about 2 inches along the posterior-internal border of the second part of the duodenum. The duct for about 1 1/4 inches before it reaches the ampulla of Vater lies on or in the pancreas. It is evident that the retroduodenal portion of the duct covered by intestine and pancreas is out of reach of palpation by ordinary means. To add to the difficulties, several lymphatic glands, prone to enlargement, exist along this tract and render a positive diagnosis as to the presence or absence of stone impossible without further exposure. Vautrin ("Revue de Chirurgie," June, 1896) has made an extremely exhaustive and important study on the anatomy and surgery of the retroduodenal choledochus, and the following is based on his writings:

Exposure of the Retroduodenal Choledochus (*Vautrin's Operation*).—Make traction on the second or descending portion of the duodenum. This makes prominent the junction of the intestine and the gastro-hepatic omentum. Beginning at this prominent point, incise the peritoneum parallel to the convexity of the duodenal angle, and prolong the incision along the external border of the second segment of the duodenum, so as to free it from its external serous attachments. This soon exposes that portion of the duct which lies in a groove on the anterior surface of the pancreas. Lower down the duct is embedded in the pancreas and the exposure is more difficult, as various lobules of the gland lying between the duct and the intestine are closely adherent to the muscular coats of the latter. Blunt dissection alone no longer avails; the scissors must be employed and portions of pancreatic tissue must be sacrificed rather than intestinal wall. One and one-fourth inches of the duct may be exposed as above. A further exposure may be made, but to do this the thermocautery ought to be employed because of the numerous veins present. By the above measures the duct can be exposed to a point about 3/8 inch from the ampulla of Vater.

Without previous knowledge of Vautrin's researches Cooper, of San Francisco, came to almost identical conclusions from his studies on the cadaver ("Annals of Surgery," vol. ii, 1903). Abbé also describes a similar method. These operations seem better suited to the dissecting- than the operating-room.

Jurasz (Arch. f. klin. Chir., civ, 1118) reviews the 104 operations in Payr's

clinic in which Vautrin's method was used. The mortality was 8.5 per cent. In 18 there was dilatation of the choledochus from chronic pancreatitis without stone and in one cancer of the pancreas. In 26 cases of stone in the ampulla of Vater or in the retro-duodenal choledochus it was possible to coax the stone into the upper parts of the common duct except in one instance when duodenotomy was done. In 30 cases having a history of previous icterus the permeability of the duct was verified and in 23 this exploration was made in the presence of jaundice.

When the finger, passed through the foramen of Winslow, palpates stones in the upper portion of the common duct and the stones cannot *easily* be coaxed back into the gall-bladder for removal—how should they be treated? In the earlier days of the surgery of this region several plans were devised, and under exceptional circumstances might, even to-day, be practised.

1. The stones can be crushed *in situ* between the blades of forceps protected by rubber tubing. This treatment is, of course, liable to injure the duct-walls, and in spite of careful cleansing of the duct through the gall-bladder is certain to leave detritus which may or may not be passed *per vias naturales*.

2. Needles may be passed through the duct-walls and into the stones so as to facilitate their fragmentation. The same objections apply here as to the cholelithotrity by forceps.

3. The stones may be left *in situ*, and, the cystic duct and gall-bladder being free, the operation of cholecystenterostomy may be performed. This overcomes the dangers of biliary obstruction, but does not obviate the dangers inherent to the presence of retained duct stones, viz., irritation leading to inflammation and malignant disease.

To-day the operation of choice is choledochotomy, or incision into the duct directly over the stone. The portion of the duct affected, exposed as described, is grasped or steadied by the fingers, and an incision is made along it, over the stone, of size sufficient to permit of the easy extraction of the calculus. If it is desired to close the duct wound with sutures, such should be introduced but not tightened before the stone is removed. The stitches, if of silk, include the serous and muscular coats of the duct, but not the mucous. Comparatively few surgeons use sutures, perferring to rely on drainage until such time as closure of the duct takes place naturally. The late Dr. Davis, of Alabama, was responsible for this advance. Having opened the duct and removed the calculi present at the site of incision, pass a probe downwards to the duodenum to insure the patency of the duct below, and upwards into the hepatic duct to explore for any calculi there present. This is the advice usually given, but it is, in fact, impossible by means of the probe positively to exclude the presence of stones; only by palpation with the finger inside the duct can positive knowledge be attained. Kehr strongly recommends that a rubber drain be passed up into the hepatic duct so as to provide exact drainage. Most surgeons pass a rubber drain down to the duct, fix [illegible] a stitch of plain catgut, surround it with a pack of gauze covered [illegible]

by rubber tissue, and close the external wound except where the drain and pack emerge.

Even if the wound in the duct be sutured, drainage is essential. When the gall-bladder has been opened, it may be treated in various ways: (*a*) It may be excised—cholecystectomy. (*b*) The opening in it may be sutured to the parietes—cholecystostomy. (*c*) It may be drained in the same fashion as the common duct is drained.

The Mayo brothers have systematized the operation of choledochotomy in the following manner:

Step 1.—Open the belly by the Robson incision. Separate adhesions and explore the gall-bladder and ducts. If the gall-bladder is distended remove part or all of its fluid contents by the trocar and cannula or by incision. The gall-bladder in case of common-duct stone is commonly much shrunken.

Step 2.—Pull part of the liver out of the wound and towards the right. This exposes the ducts and brings them within reach. Protect the belly cavity with gauze packs. With the fingers palpate the stone in the duct, and steady it so that it can act to the duct the part of a ball thrust into a stocking that is being darned. (Elliot.) Introduce, *longitudinally*, two fine plain gut sutures into the duct (Fig. 659). These penetrate the whole thickness of the duct-wall, if such is necessary to get a firm hold. Using the sutures as tractors, make an incision into the duct over the stone. Extract the stone. Explore the duct with the finger in it. The finger passed up the duct and pulled out again (slightly crooked when being pulled out) acts as the piston of a pump and sucks down any small stones which may be in the upper part of the common or in the hepatic ducts. In the large majority of cases the finger can and must be passed up to the division of the hepatic duct and down to the papilla; this can be much simplified by exerting counterpressure on the duodenum and pancreas. Ducts not large enough to admit the finger are usually thin-walled, not much adherent, and hence palpable from the outside. It is only in difficult cases, *i.e.*, where many adhesions are present and the duct-walls are thickened, that finger exploration inside the duct becomes absolutely necessary. In all cases when it is possible, this method of exploration should be used. Diverticula hide stones from the probe or scoop, as the nature of the calculi lets them give no feeling of "grit" when touched by metal; only the finger can recognize them.

Step 3.—Treatment of the wound in the duct.

(A) If it is possible to do a cholecystostomy, and the cystic duct is sufficiently patent to permit of biliary drainage, the wound in the duct may be treated as follows: Cross the one end of suture X with that of suture Y (Fig. 660), and the end of suture X^1 with that of suture Y^1 but do *not* tie them. Place the strip of gauze G (Fig. 661) longitudinally over the wound in the duct and over the crossed sutures. Tie the sutures around the gauze strip, the free side of which is covered by a layer of rubber tissue. This closes the wound and fixes the gauze over it, so that should bile escape it cannot wash away the gauze, and an efficient drain is provided. Bring the end of the gauze out

through the abdominal wound. A folded strip of rubber dam or gutta-percha tissue is preferable to the gauze. Establish a cholecystostomy. Close the excess of abdominal wound.

(B) If owing to the small size or the diseased condition of the gall-bladder a cholecystostomy is impossible or improper, proceed as follows: Prepare a 1/4-inch tubular drain wrapped with gauze to within a distance of 1/8 inch of its end. Introduce the bared end of the tube *into* the common duct; the covering of gauze prevents its going in too far. Thread one end of the suture X-X[1] on a needle, pass it through the tube and tie it to the other end of the same suture. Do the same with suture Y-Y[1]. Bring the end of the drain out of

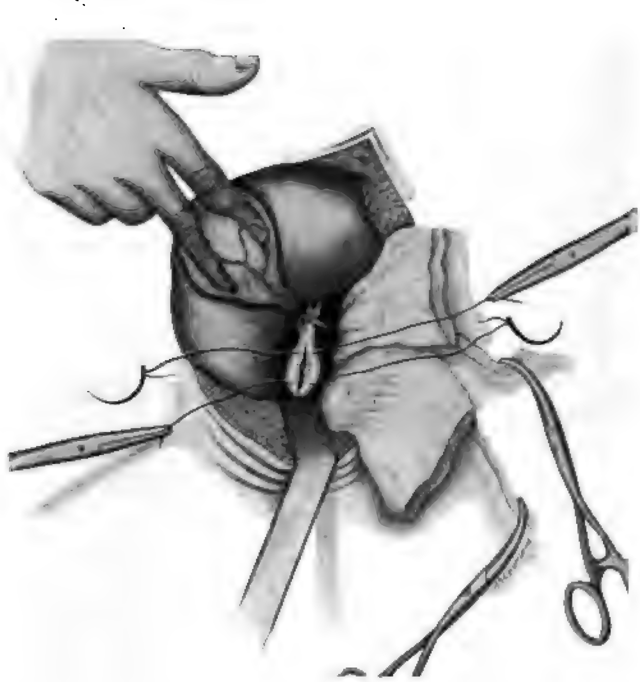


FIG. 659.—Choledochotomy. (*Mayo.*) From sketches by the author.

the wound and close the excess of abdominal wound (Fig. 662). The end of the tube introduced into the duct should be beveled or cut in the "fishtail" fashion. A small gauze pack around the above and tied to the suture Y-Y[1] or X-X[1] is an added safety. McArthur introduces a rubber tube into the duct but directs it *towards* the duodenum instead of towards the liver. The caliber of the tube must be less than that of the duct. The object of this radical change in method is that solutions of any appropriate kind in any desired quality can be introduced practically directly into the duodenum. In cholemic nephritis with anuria the introduction of 1, 2 or even 3 liters of hypotonic salt solution has saved a number of otherwise hopeless patients. In acute septic nephritis Matas has

performed cholecystostomy on the normal gall-bladder and saved his patient by instilling much warm Vichy Celestin.

(C) Hepaticus drainage. Through the wound in the common duct introduce a drainage tube upwards to beyond the opening of the cystic duct.

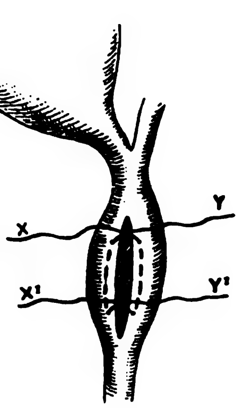


FIG. 660.

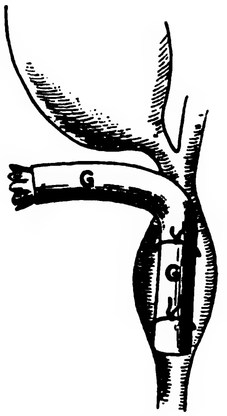


FIG. 661.

FIGS. 660 AND 661.—Treatment of incision in common duct.

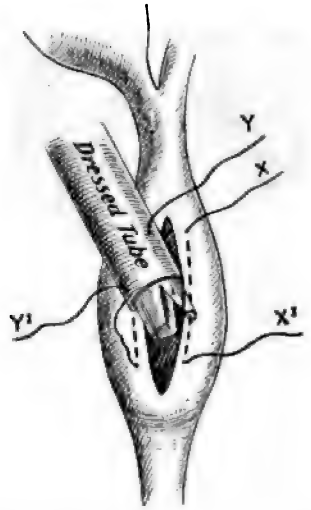


FIG. 662.—Drainage of common duct.

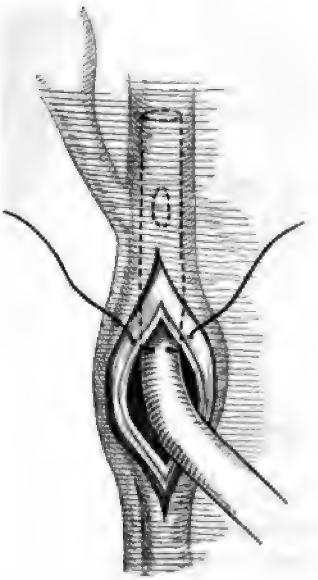


FIG. 663.—Hepaticus drainage.

The best tube to use is a soft-rubber catheter (No. 25 to 30 F.), with its end cut off and a lateral opening made about ¾ inch from its extremity. Fix the tube to the wound by a catgut stitch (Fig. 663). Close the excess of the wound in the duct and the hepato-colic omentum by a continuous catgut stitch. Drain the gall-bladder with a dressed rubber drain. Between the

neck of the gall-bladder and the wound in the common duct, place a strip of iodoform gauze. With fine catgut stitch the end of a large split rubber tube to the common duct immediately below the exit of the drain. (The same suture used for closing the duct wound is suitable for fixing the large split tube.) Make the split tube embrace or almost embrace the common duct drain, the gall-bladder drain the strip of gauze and any other drain which may be required (Fig. 664). Tie a thread of catgut round the split tube so as to hold all these drains together, and let them all protrude, as one, through the abdominal wound.

Another method of reaching the calculus, viz., by splitting the gall-bladder and both the cystic and common ducts, is described under cysticotomy.

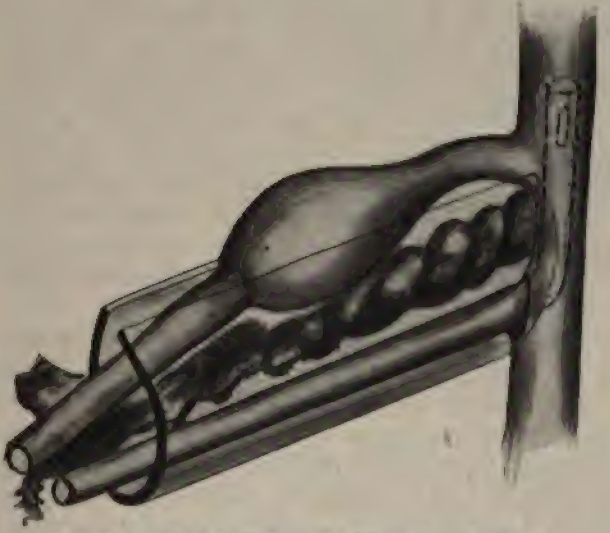


FIG. 664.—Cholecystostomy and hepaticus drainage.

When the obstructing calculus exists very low down in the common duct, one may reach it by the transduodenal route. McBurney ("Annals of Surgery," Oct., 1893) was the first to perform this operation of *duodeno-choledochotomy*. Kocher is a supporter of the method. Mr. Mayo Robson thus describes the procedure:

"The termination of the common duct, including the duodenum, should be grasped between the finger and the thumb of the left hand and the anterior wall of the gut cut through, thus exposing the interior of the posterior wall of the intestine with the termination of the common duct running in it. Either the duct can be laid open from the papilla, or the stone may be cut down on, through the posterior wall of the duodenum. Bile flows freely as soon as the obstruction is removed, and it must be mopped away as it flows, since it always contains pyogenic microbes and is therefore infective. As a rule, there will be no trouble with bleeding and no sutures need be placed in the posterior wall of the duodenum. The incision through which the duodenum

has been opened should be sutured by a continuous catgut suture for the mucous membrane and a continuous silk suture for the peritoneum. No drainage is required. For calculi situated in the lower third of the common duct, especially if impacted in the diverticulum of Vater, the operation is decidedly preferable to the ordinary choledochotomy, as not only is it easier, but an incision of the narrow orifice of the bile-duct in the duodenum leaves a patent opening, which will allow any other concretions that may have escaped observation to pass without difficulty." ("Dis. Gall-bladder and Bile-ducts," 1901, p. 269.)

Sencert ("Revue de Gynécologie et de Chir. Abdom.," x, 47) gives the following anatomical rules for finding the ampulla of Vater by the duodenal route. (*a*) Observe whether the ascending colon is fixed or is provided with a mesocolon. (*b*) If the ascending colon is fixed (80 per cent.), incise the duodenum transversely immediately above that portion or angle of the colon which lies on its anterior surface. (*c*) If the ascending colon has a meson (20 per cent.), find the root of the transverse mesocolon and incise the duodenum immediately above this. This leads directly to the ampulla of Vater.

J. C. Hancock ("Annals of Surg.," Jan., 1906) has collected 62 cases in which the common duct has been reached through the duodenum. The death rate was 12.6 per cent. In 57 of the cases operation was for the removal of gall-stones, in 2 for the relief of neoplastic obstruction of the papilla and in 2 for the removal of pancreatic calculi.

Kehr and Mayo have supplemented the operation by opening the common duct high up and pulling strips of gauze through the duct from one opening to the other, thus insuring the removal of all fragments of stone.

Hepato-cholangio-enterostomy.—This operation consists in effecting an anastomosis between the gut and the smaller hepatic ducts. It is indicated in those cases in which there is present permanent obstruction of the common and main hepatic ducts or of the common and cystic ducts. Under the above circumstances a cholecystenterostomy would be useless, and a cholangiostomy (*i.e.*, a union of the opened small bile-ducts to the skin) as practised by Kocher and Langenbuch is objectionable, as it establishes a permanent biliary fistula. Hepato-cholangio-enterostomy was suggested by Baudouin, and Langenbuch, but first practised by Hans Kehr. ("Centralblatt f. Chir.," 1904, No. 7.)

The Operation.—Step 1.—Exposure of gall-bladder region, preferably by Mayo Robson's incision. If necessary, excise the gall-bladder.

Step 2.—From a convenient part of the lower margin of the liver excise a strip of liver tissue about two and one-half inches long by about one inch wide. With the thermocautery stop the hemorrhage and at the same time burn a hole in the liver of such a depth that several moderate-sized bile-ducts are opened.

Step 3.—Choose a segment of gut, preferably duodenum, which can be brought up to the hepatic wound without tension. In this gut make an opening 2½ inches long, and suture it to the margins of the liver wound. In Kehr's case only a few sutures cut loose while being tied, and he was able to close the belly without packing the wound. In most cases one imagines that packing

with iodoform gauze, or at least the use of one or more cigarette drains, would be of much value. In the case operated upon recovery ensued and the liver tissue seemed to tolerate the necessary direct contact with intestinal contents.

Sullivan ("Trans. Surg.," Sect. A. M. A., 1912) has excised the common duct in dogs and restored the continuity of passage in the following manner: Push a soft-rubber tube not less than 1/4 inch in *inside* diameter *into* the hepatic duct and fix it there by two or three non-absorbable sutures. Push the other end of the tube through the stump of the common duct into the duodenum for not more than 1 inch. If the stump of the duct is not available, close its remnant with suture or ligature; puncture the duodenum, introduce the tube through the puncture and fix it there with sutures, inverting the edges of the duodenal wound round the tube. Lay the exposed portion of the tube along the surface of the duodenum and by means of sutures bury it in the duodenal wall exactly as is done in Witzel's gastrostomy or in cæcostomy. Unite that portion of the tube between the hepatic duct and the duodenum to the edge of the gastro-hepatic omentum. Pull up the great omentum and completely cover the rubber tube with it. Fix the omentum in place with sutures.

Remark.—Is it not very probable that infolding of the duodenal wall might cause such diminution of the lumen that a gastro-enterostomy might be necessary?

Wilms ("Berliner klin. Woch.," 1912, No. 12) reports five cases in which he substituted a rubber tube for the common duct with good results. His method is similar to that of Sullivan.

W. J. Mayo finds that jaundice recurs in the course of a year or two after an apparently successful operation of this kind, due presumably to stenosis of the rather unnatural new passageway."

When the common duct has become closed and a cholecystenterostomy is not available the common or the hepatic duct may be anastomosed to the duodenum. If the duct is much dilated it may be united to the gut by lateral anastomosis. If this is impossible the duct may be divided transversely; the duodenum, mobilized after the manner of Vautrin, Cooper, Finney or Kocher, is easily lifted up to lie without tension near the open duct and united by a few catgut stitches to the tissues beside the duct. It is now possible to make an end-to-side anastomosis between the duct and the duodenum (W. J. Mayo, Annals of Surg., July, 1905).

L. L. McArthur in 1908 performed an operation which has been subsequently and independently devised by Wilms and others. Expose and divide the duct at the site of stricture; ligate its duodenal end. Insert into the open hepatic end of the duct a small rubber drainage tube the end of which has been twice turned back on itself, making a double revere. Pass 3 or 4 inches of the other end of the tube into the duodenum through a small opening around which a purse-string suture has been inserted. Tie the suture snugly around the tube. Suture the stump of the duct covering the rubber drain, to the duodenum. The result is an end-to-side anastomosis. The rubber tube when it has served its purpose escapes per rectum in a few weeks.

A. J. Walton (Surg., Gyn., Obst., Sept., 1915) where direct anastomosis was impossible, performed a plastic operation successfully as follows: Insert a rubber tube into the duct and fix it there with a catgut suture (if the tube has been soaked for a few days in liquid paraffin, as advised by McArthur, it will not permit coagulation of the bile in it). From the anterior surface of the duodenum reflect a flap *downwards*, long enough to reach to the duct and wide enough to surround it without tension. Close the wound in the duodenum leaving enough of it open, beside the pedicle of the flap to admit the end of the tube. Insert the end of the tube into the duodenum. Pull the duodenum as near to the duct as possible and anchor it with sutures to any convenient tissues. Suture the flap around the tube and to the duct. This operation is very similar to one of v. Stubenrauch's but the flap has its pedicle below and the end of the tube is *not* brought out through a second puncture in the gut.

v. Stubenrauch's Methods.—Very rare cases occasionally arise in which owing to a small size of gall-bladder, adhesions in the operative territory, immobility of the omentum (*e.g.*, because of herniæ, etc.) it is impossbile to perform any of the ordinary direct anastomoses between the gall-bladder or ducts and the alimentary canal, and yet it is absolutely necessary to short circuit an obstructed duct.

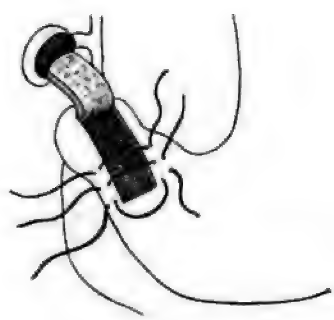


FIG. 665.—Stubenrauch's operation.

v. Stubenrauch ("Archiv für klin. Chir.," lxxix, 1015) endeavored to solve the above puzzle in a case of chronic pancreatitis with complications in the following fashion: At a previous operation the shrunken gall-bladder and the common duct were both drained, leaving a fistula leading from the skin to the duct.

Method I.—Make an incision through the skin around the fistulous orifice. Separate the fistulous tract from its surroundings, leaving connected with the common duct like a vermiform appendix. Make an incision into a convenient portion of the stomach or duodenum and implant the distal end of the fistulous tract into this. In v. Stubenrauch's case the implantation into the duodenum caused narrowing of the pylorus, so gastro-enterostomy was done. Result was failure due to necrosis of fistulous tract.

Method II.—Expose the openings in gall-bladder and common duct. Pack the common duct with gauze and see if the bile will flow into the gall-bladder; if it will, use the gall-bladder for the anastomosis; if it will not, then use the duct for this purpose. Expose the duodenum and pyloric portion of the stomach. From the duodenum and stomach reflect a flap with pedicle above, about 1 inch wide and long enough to reach without tension to the opening in the gall-bladder or duct. This flap consists of all the coats of the viscus (peritoneal, muscular and mucous) (Fig. 665). Turn the flap upwards. Occlude the opening in the common duct by laying the serous surface of the flap over it. Unite the distal end of the flap to the opening in the gall-bladder with a few

catgut sutures. Close the wound in the stomach and duodenum, leaving room for a drainage-tube at the base of the flap. Introduce a drain between the gut and the gall-bladder. Partially close the external wound. Pack and drain.

Result.—Complete immediate success. About six months afterwards there was slight and temporary evidence of local trouble.

v. Stubenrauch *suggests* an improvement of Method II and also an alternate procedure.

Method III.—Make the gastro-duodenal flap as above, but unite its lateral edges over a drainage-tube (Fig. 666) so as to form a tube lined with mucous membrane. Unite the free end of the flap to the opening in the gall-bladder (or in the common duct as the case may demand) (Fig. 667). Make a small opening into the duodenum a short distance distal to the flap and through this make the end of the drainage-tube emerge. Unite, with sutures, two folds of duodenal wall over the drainage-tube for a short distance exactly

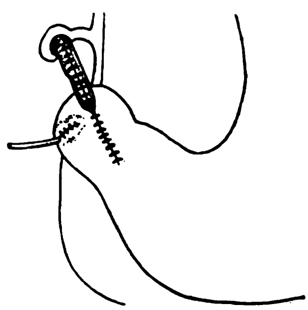


FIG. 666.

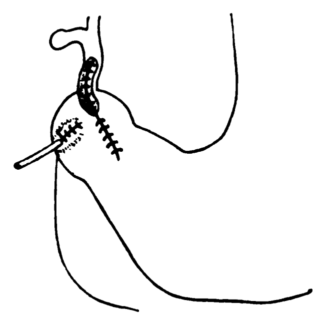


FIG. 667.

FIGS. 666 AND 667.—Stubenrauch's operation.

as in Witzel's operation for gastrostomy (Fig. 667). Bring the end of the drainage-tube out through the abdominal wound. Close the wound in the stomach and duodenum. Pack and drain the operative area. Close the excess of abdominal wound. By this method drainage by a rubber tube is provided from the gall-bladder (or common duct) through the new-formed bile-duct, through the duodenum, through the duodenal wall by an oblique canal out to the skin. When repair is complete the tube is easily drawn out and the oblique duodenal fistula quickly closes. If any stenosis is threatened by the operation a gastro-enterostomy must be done.*

Method IV.—A biliary fistula is present. It is believed that any ordinary method of cholecystenterostomy is impossible. It is desired to make the cutaneous opening of the fistula empty itself into the intestine.

Open the abdomen immediately to the right of the middle line. Choose a freely mobile loop of small intestine (one which may be made to reach the

* It will probably be wise to perform a gastro-enterostomy in any of these complicated plastic operations because there is certain to be some stenosis and if any of the sutures cut loose there will be a fistula which, even if only temporary, will permit of the escape of the gastric contents and lead to starvation.

region of the fistula). Divide the upper end of this loop and anastomose the open end of the proximal gut to the side of the lower portion of gut at a point about 4½ inches below the line of section (Fig. 668.) Make an incision through the skin alone, immediately below the biliary fistula. Introduce a forceps into this wound and burrow a canal between the skin and aponeurosis down to the laparotomy wound. With the forceps pull the end of the lower segment of gut (temporarily closed by a ligature) through the subcutaneous tunnel and unite it to the cutaneous opening of the biliary fistula. (It may be necessary to mobilize the end of the fistula slightly). Close the laparotomy wound, being careful not to constrict the portion of gut where it passes through

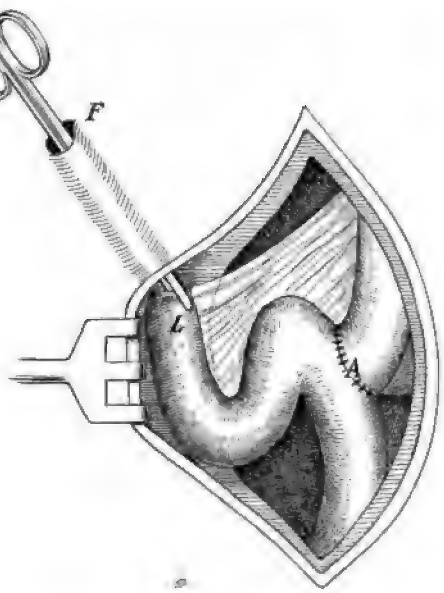


FIG. 668.

A. Anastomosis between end upper segment gut and side lower segment. *F.* Biliary fistula and incision through which forceps is passed subcutaneously to grasp and pull up to *F* the segregated portion of lower segment of gut *L.*

the deep structures of the belly-wall. It might be wise to supplement the longitudinal laparotomy wound by a small transverse incision through the rectus and aponeurosis at the point where the segment of gut passes through these structures.

The author used this method in one case (reported by Sutton, "Annals of Surg.," Sept., 1910). The segment of intestine passing under the skin to the fistula retained its vitality but acted as a fæcal fistula.

These methods of v. Stubenrauch have been suggested for certain rare and very difficult cases. Only one of the methods has been used with success. They are described here as they are worthy of consideration and *may* be helpful in an emergency.

INDICATIONS FOR AND CHOICE OF OPERATION

It is undoubtedly true that in at least one-half of all cases of gall-stone disease in which diagnosis has been made, an apparent cure may result from medicinal treatment. Scientifically such a "cure" is generally merely apparent, as the calculi remain *in situ*, but are at rest and give rise to no evident trouble. The patient considers himself well, but he is always exposed to relapse, and the continued presence of the stones is to-day believed to be conducive to malignant disease. Some surgeons believe that every case of gall-stone disease ought to be submitted to early operation. Winiwarter was the first to promulgate this dictum and Riedel takes much the same ground. W. J. Mayo says that the successful passage of the calculus *per vias naturales* is not a contraindication but a positive indication for operation, as there are always more calculi to follow, and the next ones may become impacted in the common duct, thus necessitating a grave instead of a safe operation. Few modern surgeons advise much loss of time before operation is decided on. In the writer's experience there have been a number of cases where the symptoms were apparently trifling, and yet exploration showed advanced disease. There is great difficulty and danger in operating upon many of the old cases; adhesions and contractions alter the anatomy most confusingly, and all conceivable difficulties arise. Early operation, before the common duct is involved, is easy, and on the whole very safe.

Whether cholecystostomy or cholecystectomy should be the operation of choice is not entirely easy to answer. If the operation has been rendered difficult owing to adhesions from old inflammation, etc., and if the surgeon has not had much experience, then undoubtedly cholecystostomy is the preferable method. The same is true in cases of phlegmonous cholecystitis or gangrene when the patient is too ill to bear cholecystectomy.

In discussing the treatment of interstitial pancreatitis, Robson ("Surg., Gyn., Obstetrics," Jan., 1908) writes: "This brings into prominence the undesirability of removing the gall-bladder as a routine procedure in operating for gall-stones, for unless it is seriously damaged or ulcerated, or is the seat of malignant disease, or unless there is ulceration or stricture of the cystic duct, removal is quite unnecessary. I think it better practice to drain it simply and not to perform cholecystectomy, since on some future occasion, should trouble develop in the deeper ducts or in the pancreas, and the gall-bladder be absent, it will be impossible, with few exceptions, to short-circuit the obstruction. Moreover, after cholecystotomy gall-stones have no greater tendency to reform than they have after cholecystectomy, and should cholelithiasis again develop, it will be in the common duct, a much more serious position than if in the gall-bladder."

Cholecystectomy "is contraindicated in all cases of non-patency of the common duct, and it should not be resorted to under the idea that it will prevent the formation of gall-stones, as calculi may form in the bile-duct, within the liver, or below it."

Roswell Park, S. J. Mixter and others have long urged that all diseased gall-bladders should be treated on the same principle that leads to removal of the vermiform appendix when diseased. All surgeons are widening the indications for cholecystectomy and narrowing those for cholecystostomy. The fact that carcinoma is found present in a considerable number of thickened gall-bladders is a great incentive to excision. Mayo finds that while chronic pancreatitis becomes much improved after cholecystostomy yet when the fistula closes the symptoms often recur and can be cured only by removing the gall-bladder.

C. A. McWilliams ("Presbyterian Hospital Reports," N. Y., 1906) in a careful analysis of the results and after-results of 186 operations upon the liver and gall passages finds the immediate danger of cholecystectomy to be 1.5 per cent. greater than that of -ostomy, but that the permanent results of the -ectomy are very much better than those of the -ostomy.

The question is often asked, Are gall-stones liable to form again after they have been removed by any of the above operations? The experience of Kehr, Robson, the Mayos, Riedel, and others, an experience amounting to many thousands of cases, teaches that if the calculi have been all removed there is no recurrence. In the hands of less experienced operators apparent recurrences crop up, but these are usually cases of stones overlooked in the original operation. The younger practitioners must remember that operation is not directed merely against the gall-stones themselves, but against the infective processes which give rise to them and against the complications which they occasion. The author remembers well one case in which a complete cure attended the purely medicinal treatment of gall-stone disease, but the patient succumbed to the remote results of the lithiasis, viz., an extensive adhesive peritonitis causing obstruction of the first portion of the duodenum. Operated upon early, this case would have been easily cured; a late and compulsory operation was fatal.

Cholecystostomy may be indicated as a means of introducing into the duodenum directly, rapidly and repeatedly larger or smaller quantities of various liquids in the treatment of anuria, etc. (McArthur; Matas).

The indications for cholecystenterostomy have been sufficiently described in earlier paragraphs.

COLOHEPATOPEXY OR COLON SUBSTITUTION

E. W. Andrews ("Journ. Am. Med. Assoc.," Sept. 16, 1905) notes the severe gastric disturbances which follow wide adhesion between the liver and the anterior surface of the stomach. If these adhesions are separated they necessarily reform. Andrews endeavors to arrange matters so that where they do reform they will be harmless.

Step 1.—Exposure through a free right rectus incision.

Step 2.—Note the shape, position and mobility of the stomach. Usually numerous short bands or a broad adhesion will be seen between the liver and

a large part of the pyloric end of the stomach. Divide or separate the adhesions at the expense, if necessary, of the liver rather than of the stomach. Inspect the patency of the pylorus by passing the finger through it in the usual fashion.

Step 3.—All adhesions having been freed and the stomach being in normal position, pull upwards the transverse colon and with it some omentum. Thrust these into the space between the liver and pylorus. Stitch the colonic omentum to the gastro-hepatic ligament. The more loose omentum can be interposed the better it is.

Andrews has had excellent results from this colonic interposition or suspension.

OPERATION FOR ECHINOCOCCIC CYSTS OF THE ABDOMEN

Echinococcic cysts are composed of a structureless true capsule or wall on the inner surface of which there develop the young heads of the parasites. The cavity of the cyst is filled with thin fluid in which lie numerous subsidiary or daughter cysts. The whole cyst is surrounded by a firm connective-tissue capsule developed from the liver itself. The cysts may be single or multiple, usually the former.

Out of 18 cysts operated on by Mabit the site of disease was: right lobe liver, 8; left lobe, 3; spleen, 2; omentum, 3; mesentery, 2. The liver being the organ usually affected, the operations here described will have special reference to it.

Several methods of operating on echinococcic cysts have been recommended, but most of them have been discarded in favor of more radical measures. Aspiration is ineffectual and dangerous. Injection of antiseptics—*e.g.*, bichloride of mercury or formalin solution—is dangerous and indefinite. The best method of treatment is enucleation.

According to the site of the disease access is gained to it by one of two routes:

(A) **Abdominal Route.**—When the disease can be reached by this route, and it usually can, it is the preferable one. Open the abdomen by a vertical or oblique incision over the most prominent part of the tumor. Explore the liver, etc., to make sure of the diagnosis, to ascertain whether the disease is single or multiple and to satisfy one's self as to anatomical relations. With gauze packs thoroughly isolate the field of operation from the peritoneal cavity. Protect the edges of the abdominal wound with gauze. The firm false capsule of the cyst will usually show prominently on the surface of the liver. Seize the false capsule with a stitch or a volsellum. With a trocar and cannula empty the cyst of its fluid contents, thus rendering its walls flaccid. Pull the cyst-wall as far as possible out through the abdominal wound and incise it freely. With fingers, strips of gauze, and salt solution gently evacuate *all* daughter cysts. If possible, peel the true cyst-wall from the false fibrous capsule, but do not endeavor to excise the latter.

Prepare a rubber tube by surrounding it with a few layers of gauze and cover the gauze with rubber tissue. Introduce this "dressed tube" into the cyst,

and with plain catgut suture the opening in the cyst around and to the tube. Cleanse the field of operation and remove the gauze pads from the peritoneal cavity. Suture the cyst-wall, around the drainage-tube, to the parietal peritoneum. Close the excess of abdominal wound.

If secondary cysts are present and lie close to that first opened, they may be penetrated from it. Sometimes several cysts may require to be opened through several abdominal incisions. The advantage of sewing, with catgut, the opening in the cyst around and to the drain is that all leakage into the belly is absolutely avoided. The catgut remains effective until union is so far advanced that there is no danger of the peritoneum becoming soiled.

Some surgeons perform the above operation in two stages. At the first operation they expose the diseased portion of liver, pack the wound, and wait ten days or more for adhesions to form and protect the peritoneum. At the second sitting they open the cyst and treat it as already described. There is practically no greater danger in completing the operation at one sitting than in waiting for adhesions to take place, and if the cysts are multiple, the operation in two stages is entirely unsuitable.

The method of treatment outlined is known as marsupialization; its objectionable features are: long convalescence; the dangers of suppuration, and the persistence of biliary fistulæ. Marsupialization is an eminently safe operation.

Bond suggested that the cyst cavity might be obliterated by means of buried sutures, and the abdomen closed without danger. Other surgeons, after evacuating all the cyst contents, advise filling the cavity with iodoform emulsion or with saline solution, and closing it completely with suture. There is too much danger involved in this method to render it advisable. The experience of John O'Conor, Mabit, and others shows that the sutured false capsule of a hydatid cyst is very prone to suppuration, and that Bond's operation, however modified, is exceedingly dangerous. Mabit finds that if *much of the cyst-wall protrudes beyond* the parenchyma of the liver, spleen, or whatever organ it affects, such free cyst-wall may be excised and the remainder after being thoroughly dried, may be left with safety in the belly cavity. The operation of Mabit is improper unless at least $\frac{1}{8}$ of the cyst-wall is free, and unless the contents are sterile as regards pyogenic organisms.

(B) **Transpleural Route.**—When the disease is situated far back on the dorsum of the liver, presses into the subphrenic region, and cannot be conveniently reached from in front, one gains access to it by the transpleural route.

The Operation.—Excise about three inches of the eighth or ninth rib in the anterior axillary line. Suture, with catgut, the parietal to the diaphragmatic pleura. Of course, in inserting theses sutures one aims at uniting the two pleural surfaces alone, *i.e.*, without other tissues, but one never succeeds in so doing. The stitch, if effective, always includes in its loop other tissues than the pleura. Incise the diaphragm and expose the liver. Pack gauze all around the area of liver to be opened. Treat the disease as already described.

CHAPTER XLV

HERNIA

iotomy.—Formerly herniotomy was considered one of the most beau- satisfactory operations in surgery; now, however, it is rarely thought of plete procedure, but merely as a preliminary to some one of the opera- the radical cure of the hernia. Under the caption "herniotomy" it onvenient to describe the methods of combating some of the compli- net in cases of irreducible and of strangulated herniæ.

cision.—(A) ***Inguinal hernia:*** (*a*) Bassini's incision (page 604). (*b*) ı's incision (Fig. 669 and page 602). (*c*) Any more or less vertical over the hernial swelling and following its long axis. (*d*) Ferguson's (page 605).

69.—Herniotomy. (*Esmarch and Kowalzig.*)

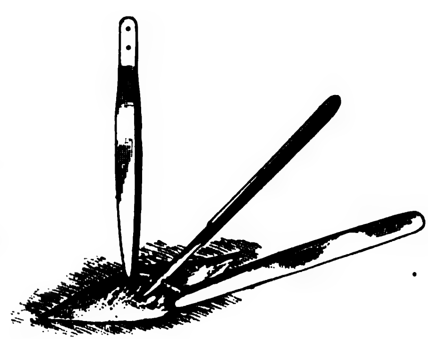


FIG. 670.

Femoral hernia: (*a*) Bassini's incision (page 594). (*b*) Vertical incision. *Umbilical and ventral herniæ:* Vertical or transverse incision.

ıe skin having been divided, one picks up the subjacent tissues layer and divides them between forceps* (Fig. 670). By this method the ac is soon reached. How may the sac be recognized? Bull says the y be recognized, first, by the presence of the subperitoneal fat im- y outside it; second, by its lead or bluish color; third, by its gliding over ents of the sac beneath it.

: the sac in inguinal and femoral herniæ is being freed from its sur- 's, especially when its neck is being isolated and dragged upon, it is

layers spoken of are not layers described by anatomists; such are rarely recog- never sought, but are such thin sheets of tissue as happen to be picked up by the

not rare to pull the urinary bladder into the hernial canal. The bladder may be recognized by its musculature, and must of course be avoided. Brunner ("Deutsche Zeitsch. für Chir.," ci, p. 562) has observed this dragging down of the bladder in 44 out of 775 operations for inguinal and femoral herniæ.

Especially in a small hernia, the finding of the sac is sometimes a matter of difficulty. Remember that the sac is a protruding pouch of peritoneum, hence to find it, *e.g.*, in an inguinal hernia, examine the internal abdominal ring and the sac will always be found as a continuation of the parietal peritoneum.

3. A portion of the sac which is non-adherent to its contents is picked up by forceps and cautiously opened with knife or scissors. The first opening is made exceedingly small and is cautiously enlarged until the finger can be introduced and discover the condition of the contents, after which the sac is widely opened.

4. Examination in cases of irreducible and strangulated herniæ almost always shows stricture of the neck by firm surrounding tissues. *Division of stricture:* (A) The classical method is to introduce the finger-nail of the left fore-finger into the stricture, the back of the finger being against the hernia, keeping it out of the way (Fig. 671). A hernia knife is laid flat on the palm of the finger and pushed along until its blunt nose has got beyond the constricting band. The edge of the knife is now turned and pressed against the stricture in such a way as to make a number of small nicks instead of any definite cut. No sawing motion should be given to the knife and its edge should always be blunt.

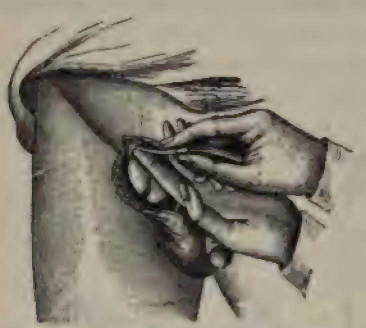


FIG. 671.—Herniotomy. (*Esmarch and Kowalzig.*)

In inguinal hernia if these precautions are adhered to, it makes little difference whether one cuts upwards and outwards, upwards and inwards, or only generally upwards, since such a knife, so used, would be extremely unlikely to injure any vessel. Should any vessel be divided and bleeding occur, it is easy to enlarge the wound and ligate the bleeding point. A herniotomy knife, while convenient, is not necessary—its work can be done by a pair of blunt-pointed scissors. (B) Most surgeons now advocate the division of the constricting tissues from without inwards, exactly as the canal is opened during a radical operation. This is the easiest, safest and best method to follow.

5. *Contents of the Sac.*—If the contents consist of healthy gut or healthy non-adherent or non-redundant omentum, they are to be reduced at once. If adhesions are present, they must be gently torn through or divided between ligatures. Sometimes adhesion between gut and sac is so firm that a thin portion of sac has to be cut away and left attached to the gut. If the omentum is redundant, inflamed or much lacerated from the division of adhesions most of it should be removed. This is done by placing a chain of ligatures across it

(Fig. 672) and cutting away the peripheral portion at a distance of *at least* one inch from the ligatures.

Remove as little omentum as possible; omentum is most valuable.

Should the gut be gangrenous, it may be dealt with in several ways:

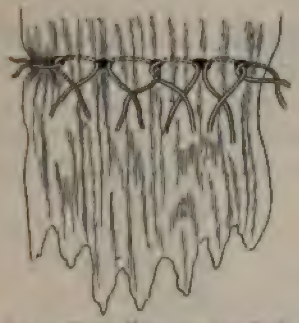


FIG. 672.—Chain ligatures applied to omentum.

FIG. 673.—Repair gangrenous gut. (*Guibé.*)

(*a*) Only a small spot on the free surface of the gut is gangrenous, the rest of the gut is healthy. Invaginate the gangrenous patch by a few Lembert

FIG. 674.—Examination of constricted gut. (*Veau.*)

sutures (Fig. 673). Examine to see if the invagination produces too much narrowing of the gut.

If the gangrene affects all or nearly all the circumference of the gut, but affects little of its long axis, use Summer's operation.

(*b*) Gangrene is extensive. Pull down healthy gut from beyond the strictures caused by the constricting abdominal opening (Fig. 674). Doubly clamp both the afferent and efferent loops of gut. If an end-to-end union is to be made, the clamps nearest the body must be protected with rubber tubing and must *not* crush. If a lateral anastomosis is contemplated, crushing forceps are best. Divide between the forceps. Ligate and divide the mesentery. Remove the excised gut and mesentery.

With through-and-through catgut sutures, close the ends of both segments of gut protruding from the clamps. Insert a purse-string suture (Fig. 675) on the body side of each clamp. Remove the clamps. Invaginate the ends of the guts, tighten and tie the purse-string sutures. Unite the afferent and efferent loops of gut by lateral anastomosis. (Instead of lateral anastomosis,

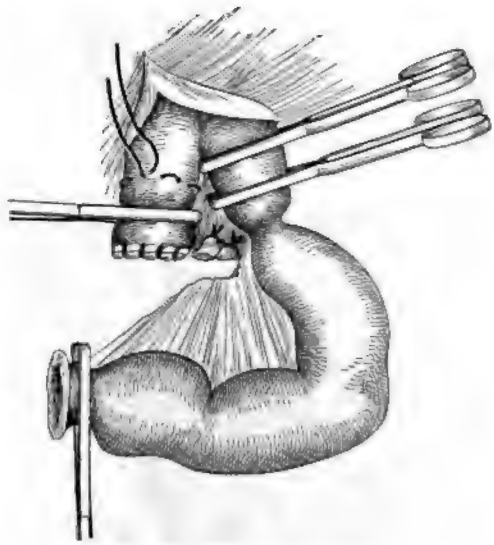


FIG. 675.—Excision gangrenous gut.

end-to-end or end-to-side anastomosis may be practised.) If there is doubt as to the viability of the gut or as to the cleanliness of the field of operation fix the united segments of gut near the wound in the parietes by means of a well-placed cigarette or oiled-silk drain.

(*c*) The general condition of the patient renders a complete operation hazardous. Excise the gangrenous segment of gut. Unite the open ends of the healthy gut to the wound, thus providing an artificial anus which may be closed subsequently. This is probably the safest plan for inexperienced surgeons to adopt.

(*d*) The general condition of the patient is poor; the temperature is about normal or even subnormal; the pulse is 120 or more; the abdomen is tense and distended. Relieve the constriction, pull down healthy gut and fix it to the wound. Incise the gut to obtain intestinal drainage. Do not remove any

tissue. Drain the whole wound freely and endeavor to keep the patient alive by suitable food and stimulants.

(*e*) In strangulated femoral hernia it is wise to recognize the fact that the small size of the femoral canal hinders or prevents the proper treatment of the gut. One, therefore, opens the abdomen immediately above Poupart's ligament; protects the belly cavity with pads; reduces the hernia (working from

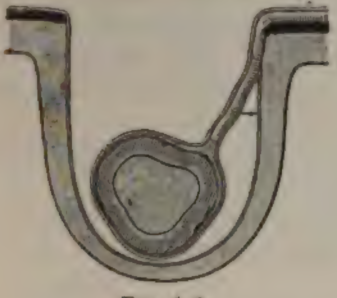


FIG. 676.

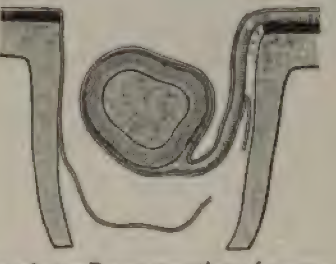


FIG. 677.—Reconstruction of meson.

FIGS. 676 AND 677.—Sliding hernia. (*Guibé.*)

the abdominal side); excises the gangrenous segment; repairs the bowel; provides drainage from below and closes the abdominal wound.

Unless contraindicated by the weak state of the patient or by the necessity of deep drainage, herniotomy ought always to be followed by an effort after radical cure. (*Vide* "Special Operations.")

Retrograde Strangulation of Intestine.—When operating for strangulated hernia remember that two portions of a loop of intestine may protrude into the

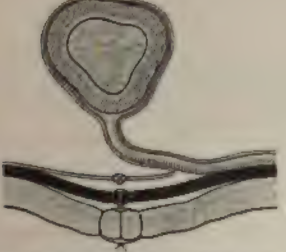


FIG. 678.—Meson reconstructed.

FIG. 679.

FIGS. 678 AND 679.—Sliding hernia. (*Guibé.*)

sac while an intermediary portion of the same loop may remain in the abdomen (Fig. 681). When this is the case it is quite possible for the blood-vessels of the intermediary portion to be caught and obstructed in the hernial ring, thus causing gangrene of the intra-abdominal loop of gut while the two portions actually in the hernia remain unaffected. In two cases (Lorenz) the strangulation was due not to inclusion in the ring of the affected, but to acute flexion

of the vessels caused by the dragging on them of the two herniated segments of intestine. Of course the intra-abdominal strangulation demands laparotomy.

SLIDING HERNIÆ

Sliding Hernia.—When large intestine is present in the hernia that part of the parietal peritoneum to which it is attached (with or without meson) may slide down and form part of the sac. This must be remembered when a portion of large intestine *appears to be* adherent to the sac. Figs. 676, 677, 678, 679, 680, explain sufficiently how the sac may be used to reconstitute the meson and protect the intestinal blood-supply.

Bull and Coley have had relapses in one out of eight cases of sliding hernia operated on by them. Fiaschi ("Australasian Med. Gaz.," Nov. 20, 1907) has had considerable experience with sliding hernia and considers relapse to be due to "the vicious habit of sliding down acquired by that portion of intestine which formed the sliding hernia."

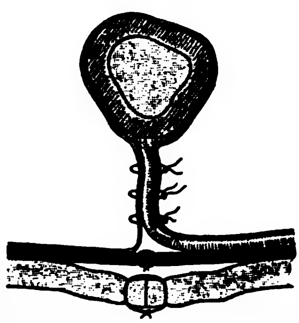


FIG. 680.—Sliding hernia, meson reconstructed. (*Guibé.*)

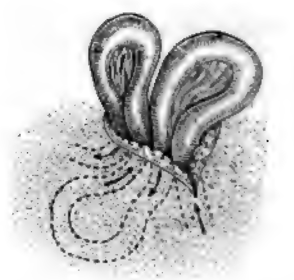


FIG. 681.—Retrograde strangulation.

To counteract the above tendency he supplements the ordinary operation on the hernia by anchoring the offending portion of the colon to the belly-wall (colopexy) through a muscle-splitting (gridiron) incision.

FEMORAL HERNIA

Bassini's Operation.—*Step* 1.—Make an incision 3 inches long, parallel to and below Poupart's ligament (Fig. 682). The centre of this incision corresponds to the centre of the hernial swelling. Divide the tissues layer by layer between forceps until the sac is reached. The superficial fascia may be surprisingly thick and fatty.

Step 2.—By blunt dissection free the sac from its surroundings.

Step 3.—Open the sac and reduce its contents. (For treatment of complications see page 590.)

Step 4.—(A) Bassini, having separated the sac from its surroundings up to its junction with the parietal peritoneum (of which it is a mere process), trans-

fixes and ligates it at this point and cuts away the peripheral portion. Many surgeons close the external wound and terminate the operation at this point.

(B) Macewen, having separated all the sac from its surroundings, pushes his finger through the femoral opening outside the sac and separates the parietal peritoneum from the parietes for a distance of ¾ inch above the opening. He then treats the sac exactly as in his operation for inguinal hernia, making it into an intra-abdominal pad. (See page 602.)

Step 5.—Make a careful survey as to the position of Gimbernat's ligament, Poupart's ligament, the plica falciformis, and the pectineal fascia. Retract the plica falciformis upwards and outwards. With a full curved needle introduce the suture A-A (Fig. 683) through the inferior and posterior part of Poupart's ligament and the pectineal fascia close to the pubic spine. About ¼ inch external to A-A introduce the suture B-B. In the same way the suture C is introduced and ought to lie about ½ inch internal to the femoral vein. The sutures A, B, and C are left for the present without being tied.

Step 6.—The plica falciformis is stitched to that portion of the pectineal fascia which normally forms the posterior wall of the femoral funnel. The insertion of these stitches is shown in Fig. 684 (X-X, Y-Y, Z-Z).

FIG. 682.—Incision femoral hernia.

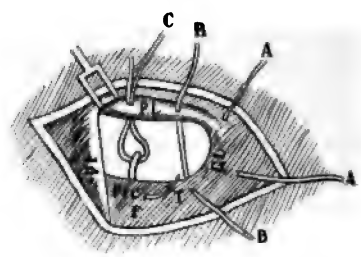


FIG. 683.—Bassini's operation.

Step 7.—The sutures A-A, B-B, C-C, are tied. This approximates Poupart's ligament to the fascia covering the horizontal ramus of the pubis. The sutures X-X, Y-Y, Z-Z are tied. This slides the plica falciformis inwards to its normal position or to an exaggeration of its normal position, and completes the closure of the canal. The long saphenous vein is left to dip unmolested under the inferior end of the plica falciformis. (N. B.—Sutures A-A, B-B, C-C close the abdominal opening into the femoral canal. Sutures X-X, Y-Y, Z-Z close the canal itself.

Step 8.—Closure of the skin-wound.

Roux's Operation.—The hernia is exposed and its sac ligated and excised as in the Bassini operation. The peculiar feature of the operation is the method of closing the femoral canal, as follows: Pass a metal staple obliquely through Poupart's ligament over the crural canal to the inside of the femoral vessels,

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carefully avoiding the vein (Fig. 685). Gently hammer the points of the staple into the pubis. The staple or nail must not be inserted too tightly lest Poupart's ligament be injured. J. Crawford Renton reports that Roux has successfully used this method in 60 cases and he himself in 10. The superficial wound is closed in the usual manner.

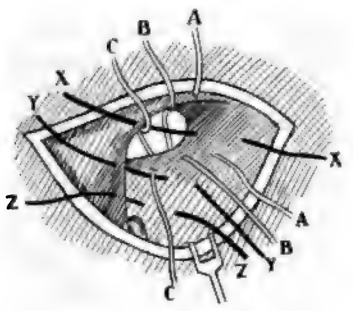

FIG. 684.—Bassini's operation.

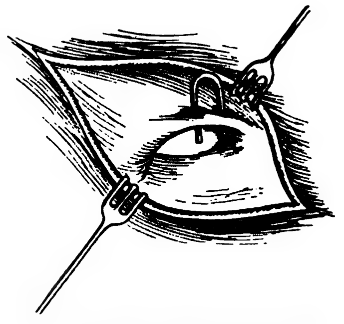

FIG. 685.—Roux's operation.

Aslett Baldwin's Operation ("Lancet," July 21, 1906).—*Step* 1.—Expose and fully isolate the hernial sac. Reduce the hernia.

Step 2.—Introduce a slightly curved director or dissector into the femoral canal in front of the sac and with it dissect a path upwards between the parietal peritoneum and Poupart's ligament to a point about ½ inch above Poupart's

FIG. 686.—(*Baldwin.*)

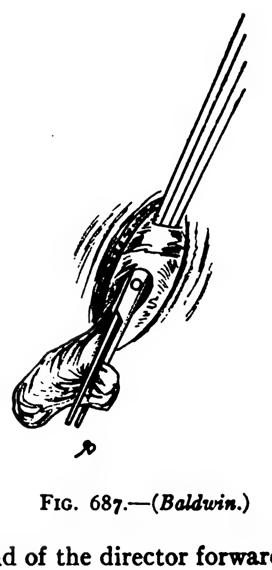

FIG. 687.—(*Baldwin.*)

ligament (Fig. 686). At this point tilt the end of the director forwards so that it can be felt through the aponeurosis of the external oblique. Make a short incision through the aponeurosis, parallel to its fibres and protrude the director through the opening.

Step 3.—Pass a forceps (sinus forceps or hæmostat) along the director from

above downwards (Fig. 687). Remove the director. Seize the distal end of the sac with the forceps and pull it through the tunnel (Fig. 688). Pull the sac as far as possible through the opening in the external oblique; ligate the neck of the sac.

FIG. 688.—(*Baldwin.*)

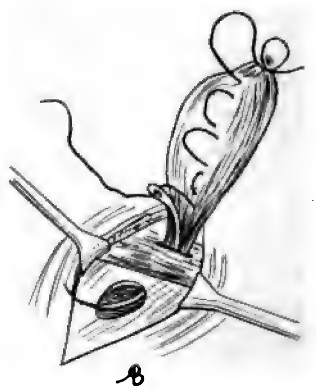

FIG. 689.—(*Baldwin.*)

Step 4.—Fix a stout stitch of catgut to the fundus of the sac. Leave both ends of the stitch long. Pass one end of the stitch several times through the sac (Fig. 689) and then make it take the following course—through the opening in the aponeurosis of the external oblique, through the neck of the sac down to the horizontal ramus of the pubis which it must hug, then downwards and forwards through the pectineus muscle and fascia to emerge through the inner part of the saphenous opening (Fig. 689).

Step 5.—Pulling on the thread, push the sac back through the opening in the aponeurosis until it is lost to sight. The tucking away of the sac may be aided by the use of a stout probe or a forceps.

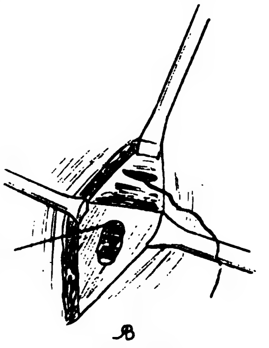

FIG. 690.—(*Baldwin.*)

The sac now lies curled up behind Poupart's ligament; from it one end of a suture hangs out through the small opening in the aponeurosis; the other end of the suture passes through the tissues on the deep side of the femoral canal (Fig. 690). Tie the two ends of the suture together; this closes the femoral canal.

Baldwin's operation seems better suited to the female than to the male because of anatomical considerations.

Dujarier's Operation.—("Journal de Chir.," Feb., 1912.)

***Step* 1.—Open** the inguinal canal as in Bassini's operation for inguinal

hernia. Retract the cord or the round ligament upwards (Fig. 691). Note the deep epigastric vessels and protect them from injury.

Step 2.—Separate the contents of the inguinal canal from the abdominal surface of Poupart's ligament and thus push the parietal peritoneum upwards until the subperitoneal fat is exposed near the femoral canal. Note the position

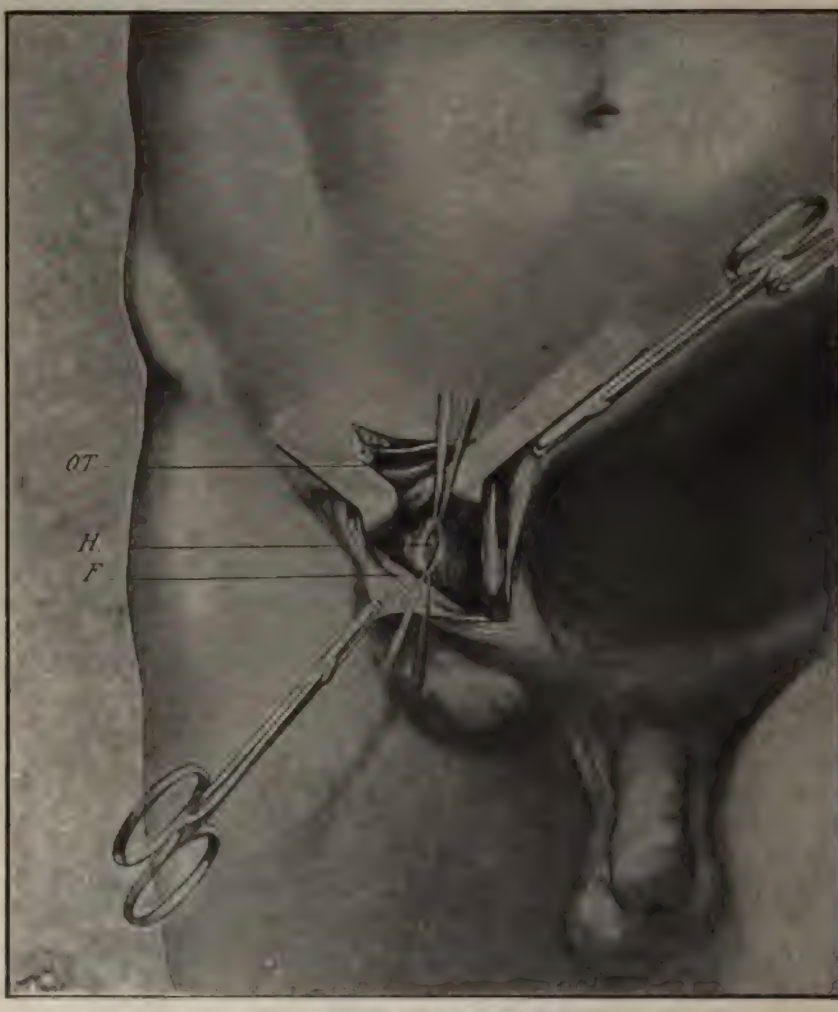

Fig. 691.—(*Dujarier.*)
O.T. Internal oblique and transversalis muscles retracted. H. Incision in peritoneum. C. Cord. F. Poupart's ligament.

of the femoral vein and protect it. Pick up the peritoneum immediately above the femoral canal and incise it. Through the peritoneal wound see if any omentum or viscus enters the hernial sac.

A. If the sac is empty and if there has not been much inflammation it is usually easy, by traction on the peritoneum, to pull the sac out of the femoral

canal into the inguinal canal where it may be treated as if it belonged to an inguinal hernia (Fig. 692). Sometimes reduction of the sac as above is impossible. If the difficulty is due to narrowness of the fibrous ring constituting the femoral canal this is easily overcome by cutting the inner edge of the ring, *i.e.*, Gimbernat's ligament.

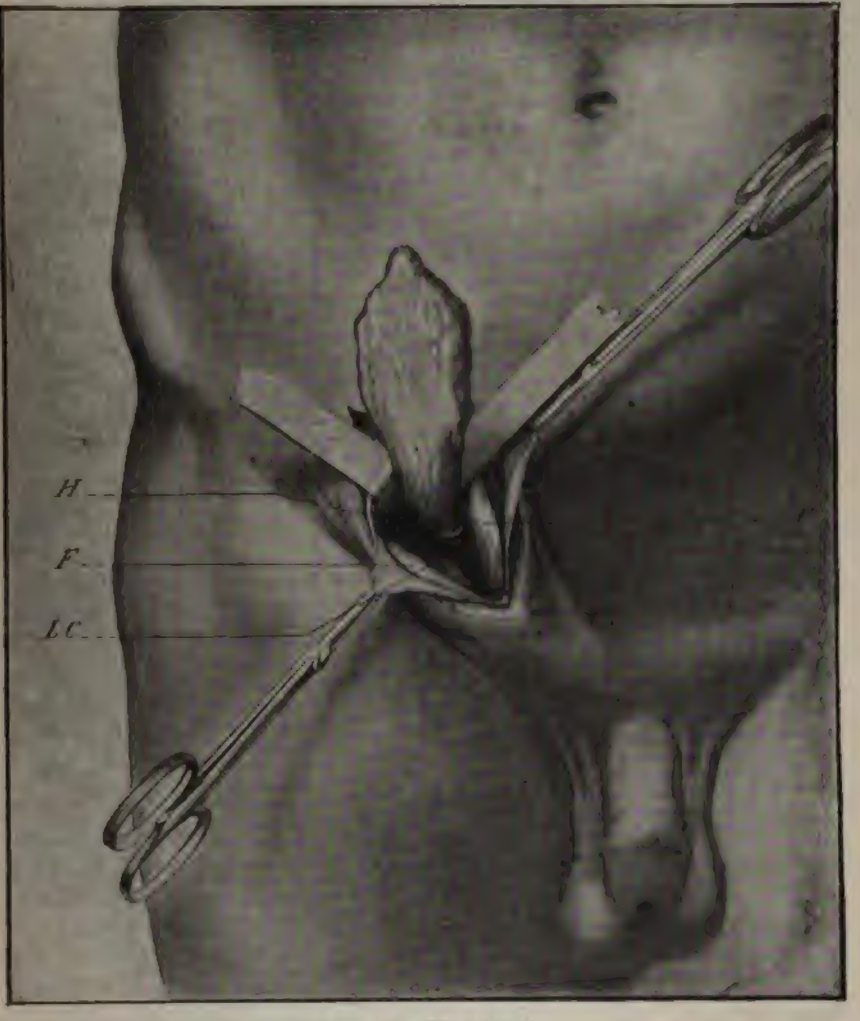

FIG. 692.—(*Dujarier.*)
F. Poupart's ligament. L.C. Cooper's ligament. H. Neck of sac ligated.

If the difficulty in reduction is due to adhesion of the sac to the tissues of Scarpa's triangle, dissect the sac free from these adhesions or if this is too difficult, divide the sac as close as possible to the adhesions leaving the adherent portion of the sac buried in Scarpa's triangle and treating the mobilized sac *secundum artem.*

B. If the sac has contents which are reducible, reduce them and treat the sac as in *A.*

If the contents are not reducible or are strangulated treat them according to the rules laid down on page 590. Dislocate the sac into the inguinal canal.

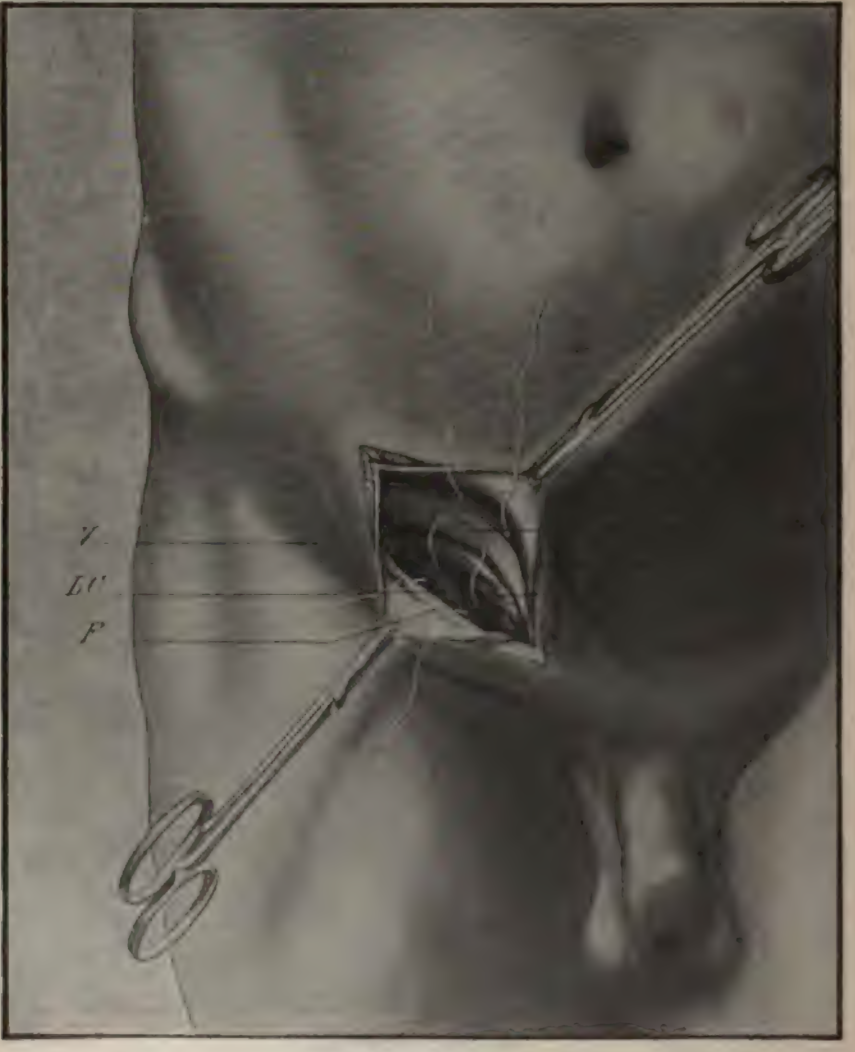

FIG. 693.—(*Dujarier.*)
L.C. Cooper's ligament. F. Poupart's ligament. O.T. Internal oblique and transversalis. C. Cord.

Step 3.—By traction on the sac try to pull forwards as much peritoneum as possible from above the neck of the sac. Note that the bladder is liable to be dragged into the wound. Ligate the sac as high up as possible (Fig. 692) and cut it away distal to the ligature.

Step 4.—Closure of the femoral canal. Insert two or more sutures through the fascia covering the horizontal ramus of the pubes just internal to the femoral vein (Fig. 693). Pass the lower end of each of these sutures through the deep part of Poupart's ligament and the upper end through the internal oblique and transversalis. The spermatic cord lies behind these sutures. When these sutures are tied the femoral canal and the deep part of the inguinal canal are closed. Reich (Beitr. z. klin. chir., lxxiii, 110) closes the inguinal by suturing the internal oblique and transversalis to Cooper's ligament and the

FIG. 694.—(*Seelig and Tuholske, Surg., Gyn., and Obst.*)

pubic periosteum *without* including Poupart's ligament. Thus the cord lies in front of the sutures.

Step 4.—Suture the wound in the external oblique. Suture the skin.

Seelig and Tuholske (Surg., Gyn. and Obst., xviii, page 58) describe an operation almost the same as Dujarier's. One of their illustrations (Fig. 694) shows the relations of the sac most admirably.

RADICAL CURE OF INGUINAL HERNIA

The older operations for the radical cure of inguinal hernia were faulty and unsuccessful because they were based on the idea that the hernia escaped from

the abdomen through a *ring*, and that if the *edges of the ring* were brought together, a cure would be obtained. The scar left by such edge-to-edge closure of the ring can never offer any great opposition to recurrence of the hernia. All the good modern operations are based on the idea that the hernia has originally passed through a more or less oblique canal, which it has converted into a ring-like opening, and that to effect a cure it is necessary to reverse the process and convert the ring into an oblique canal—narrower and more resistant to abdominal pressure than the original canal had been. All operations which carry out the above principle are successful in effecting cures.

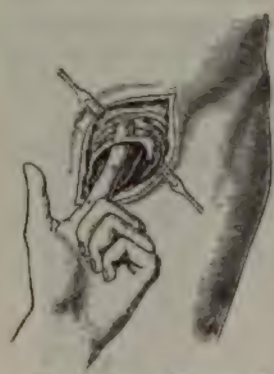

FIG. 695.—Macewen's operation. (*Esmarch and Kowalzig.*)

Macewen's Operation.—1. Make an oblique incision about 3 inches in length over the external abdominal ring. Practically a good rule is to begin the cut 1 inch above and to the outer side of the upper limit of the hernial swelling and continue the incision downwards and inwards over the hernial neck. Expose the upper part of the sac of the hernia.

2. By blunt dissection free the sac from its surroundings and from the spermatic cord, which lies posteriorly. This must be done thoroughly.

3. Reduce the contents of the sac and then open and inspect it. It is often necessary to open the sac before the hernia can or ought to be reduced. (For treatment of complications see page 590.)

FIG. 696.—Treatment of sac.

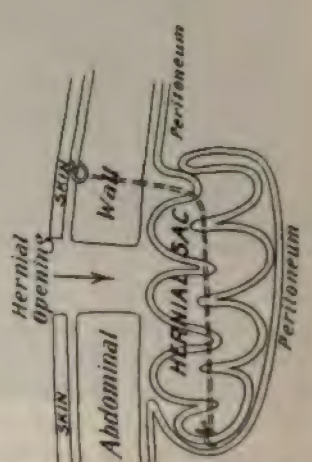

FIG. 697.—Macewen's operation.

4. Pass the finger *outside* the sac through the opening of the parietes and separate the peritoneum (of which the sac is a mere continuation) from the parietes for a space of $\frac{3}{4}$ inch on every side of the opening (Fig. 695).

,. Should the sac be too voluminous, cut off its distal end, which may be ›ved or left in the scrotum. Every time it is necessary to make an incision ıe sac the position of the cord should be ascertained.

. A stitch of chromicized catgut is taken through the distal extremity of sac, which is now hanging loosely through the abdominal wall (Fig. 696), is there tied. The long end of the suture is passed three or four times from to side through the sac, so that when pulled upon it throws the sac into .. The loose end of the thread is threaded on a Macewen hernia needle. needle, guided by the finger, is passed up *external* to the sac through the ›minal opening, and thrust outwards through the whole thickness of the ɛtes (with the exception of peritoneum and skin) (Fig. 696). If the thread is pulled, the sac will be reduced into the belly cavity (external to the peri- um), and will form a firm, puckered-up pad lying between the peritoneum the parietes (Fig. 697). The end of the thread is caught by a hemostat temporarily thrown aside.

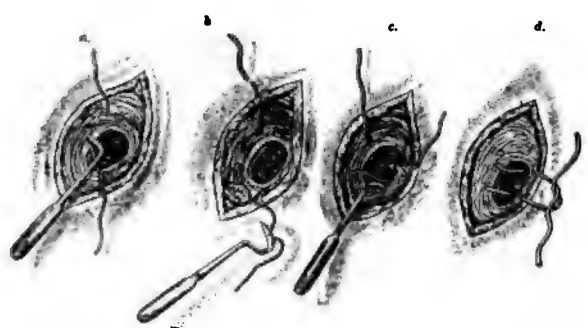

Fig. 698.—Closure of canal. Macewen's operation. (*Esmarch and Kowalzig.*)

7. A Macewen hernia needle is passed through the conjoined tendon from ithout inwards, and its point, guided by the finger in the abdominal opening, carried upwards for about 3/4 of an inch and once more passed through the ›njoined tendon, this time from within outwards (Fig. 698 *a* and *b*). By this eans a strong chromicized catgut thread is placed in position through the inner ill of the ring.

8. The lower end of the suture is now threaded on an appropriate needle d passed through Poupart's ligament from within outwards a short distance ove the spermatic cord (Fig. 698 *c*). The upper end of the suture is passed m within outwards through the aponeurosis of the external oblique. We w have a single thread which takes the course seen in Fig. 698 *d*. If one ls upon the ends of the suture, the tissues external and inferior to the open- (viz., Poupart's ligament and the aponeurosis of the external oblique) st slide over those internal and superior (viz., the conjoined tendon), and ɛn the suture is firmly tied, the obliquity of the inguinal canal is restored. : anterior surface of the conjoined tendon is in apposition with the posterior ace of Poupart's ligament. Before the suture is definitely tied the spermatic l is examined lest too much pressure be exerted on it.

9. The end of the suture used for puckering the sac is now pulled tight and fixed in the belly-wall subcutaneously.

10. The skin-wound is closed.

Macewen makes use of special handled needles, but these are not really necessary. The author has frequently used common full-curved needles gasped in a needle-holder and found them absolutely satisfactory.

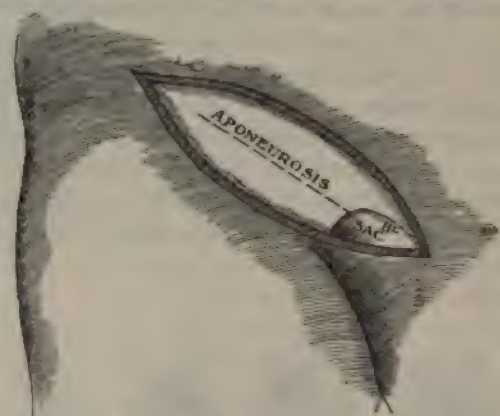

FIG. 699.—Bassini's operation.

Bassini's Operation.—1. An incision is made parallel to and ½ inch above Poupart's ligament. It begins external to the region of the internal abdominal ring and ends internal to the external ring.

2. A firm aponeurotic sheet (aponeurosis of external oblique) covering the hernia is exposed and divided in the direction of the wound with scissors or on a director (Fig. 699). Thus are formed a superior and inferior aponeurotic

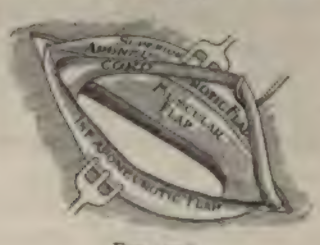

FIG. 700.

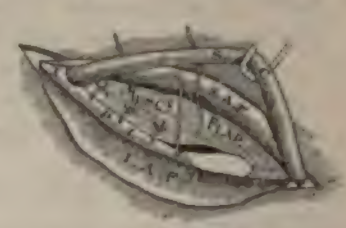

FIG. 701.

FIGS. 700 AND 701.—Bassini's operation.

flap. The superior flap is separated from the subjacent tissues for a distance of 1 or 1½ inches.

3. The hernial sac now lies exposed from its peritoneal origin to the point where it disappears into the scrotum, and is recognized according to the rules described on page 589. With blunt dissection the sac is separated from its surroundings and from the spermatic cord. This must be done thoroughly and carefully. The sac should be opened and its contents reduced or treated as described on page 590.

ɭ. Downward traction being exerted on the sac, its neck is transfixed and ted as high up as possible, and the distal portion cut off. The stump ıld retract into the belly cavity and be lost to sight. Sometimes the neck he sac is so bulky or of such a shape that ligation is impossible. In these s the neck of the sac is sewed up and the distal portion removed. By ıtever method the neck is closed and divided, special attention ought to be l to the position of the spermatic cord, as this important structure has ıuently been injured. Separation of the sac from its surroundings has ıhened all the tissues so that if placed in apposition they will unite. It is not ays necessary to excise the distal portion of the sac. After isolation, ligan and division of the neck the remainder of the sac may be permitted to drop o the scrotum. The author has occasionally seen this procedure followed by : development of a hydrocele, but if the cord and testicle are pulled out of : scrotum and the remnants of the sac turned outside-in over them no hydroe can develop and considerable dissection may be avoided. (See "Eversion Hydrocele Sac, Jaboulay's Operation.)

5. The spermatic cord is raised from its bed and held out of the way by ılunt hook. Review of the wound now shows that its upper edge consists of ee layers: (A) A deep thick layer, marked ıscular flap (Fig. 700). (Internal oblique d transversalis muscles, transversalis fascia, d external margin of the rectus.) (B) Surior aponeurotic flap. (Aponeurosis of exnal oblique.) (C) The skin. The lower ge of the wound consists of the deep layer of ıupart's ligament on which the spermatic cord rmally lies, the inferior aponeurotic flap, and the skin.

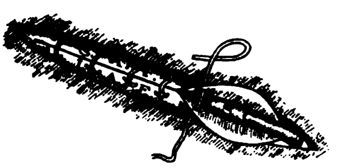

FIG. 702.—Bassini's operation.

6. A suture is now passed through the muscular flap (Figs. 700, 701) close the exit of the cord from the abdomen, and unites it to the deeper layer of ıupart's ligament. This suture must be so placed as to close the wound side the cord, but yet not interfere with its circulation. Some surgeons ıce a suture external to the cord at the point marked x, Fig. 701. This is portant. The whole edge of the muscular flap (Figs. 700, 701) is stitched the deep layer of Poupart's ligament.

7. The cord is now laid on the top of the line of suture and the superior and rior aponeurotic flaps united over it (Fig. 702).

8. The skin-wound is closed.

Ferguson's Operation.—A. H. Ferguson has noticed that a deficient origin he internal oblique and transversalis muscles at Poupart's ligament is a tful cause of recurrence after operations for the cure of inguinal hernia. expose and correct such deficiency he has devised the following operation:

Step 1.—Make a semilunar incision, with convexity upwards, from a point 'oupart's ligament 1½ inches below the anterior superior spine to a point the conjoined tendon near the pubis (Fig. 703). Reflect the flap thus ined, exposing the aponeurosis of the external oblique and the hernia.

Step 2.—Cut through the external abdominal ring and intercolumnar fascia; separate the longitudinal fibres of the aponeurosis of the external oblique directly over the inguinal canal, far beyond the internal ring, over the surface of the internal oblique, and up under the skin to a point nearly opposite the anterior superior spine (Fig. 703). This exposes all the contents of the inguinal canal, and any deficiency in the origin of the internal oblique and transversalis muscles is seen.

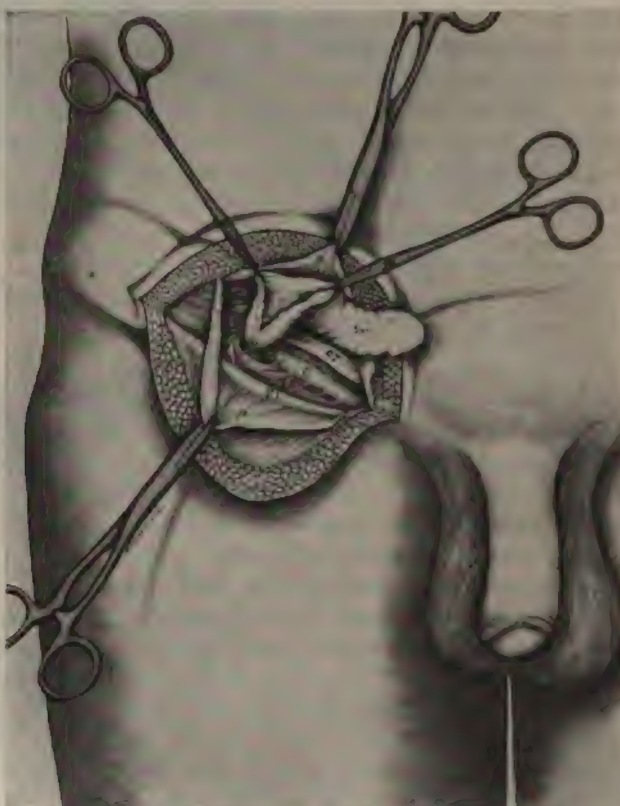

FIG. 703.—(*A. H. Ferguson.*)

Step 3.—Attend to the hernial contents and sac in the manner already described.

Step 4.—Lessen the size of the dilated internal ring by means of a few stiches (Fig. 704). Suture the internal oblique and transversalis muscles to the inner aspect of Poupart's ligament and restore their normal origin (Fig. 705). The line of suture extends fully two-thirds down the ligament. Take care *not* to split the ligament by grasping with the needle the same longitudinal fibres each time. In this step the Mayos suture the upper edge of the wound in the external oblique fascia along with the internal oblique muscle

to the inner aspect of Poupart's ligament and then make the lower portion of the fascia (continuous with Poupart's ligament) overlap the line of suture and fix it in position by means of a few stitches. Close the wound in the aponeurosis of the external oblique. Restore the external abdominal ring. Replace and suture the semilunar skin-flap.

After-treatment.—Bassini permits his patients to leave their beds and go to work after the lapse of two weeks. Macewen believes that no wound

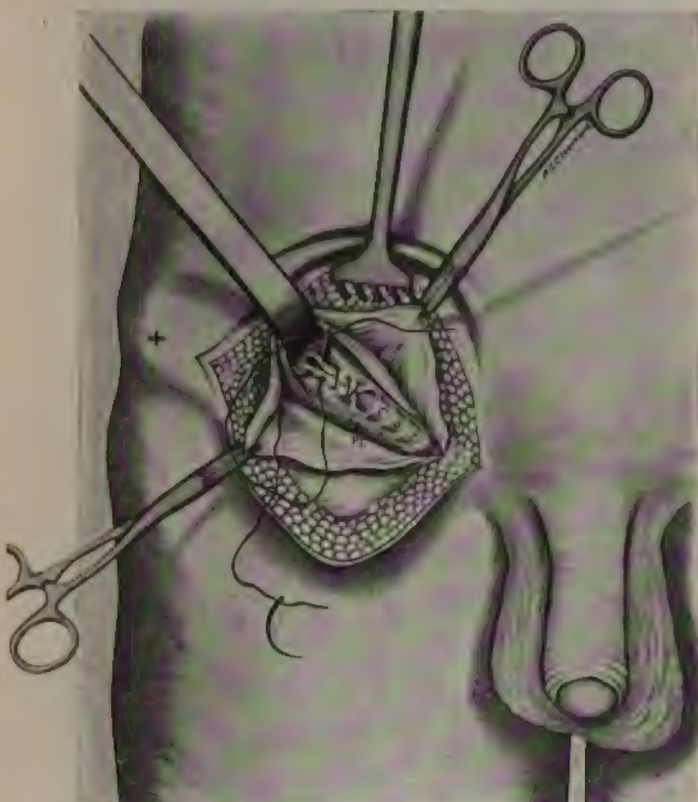

FIG. 704.—(*A. H. Ferguson.*)

is firmly healed after such a short time. When it is possible to carry out the following rules, they will be found exceedingly satisfactory:

For a period of four weeks after operation, rest in bed.

For a period of six weeks after operation, when the bowels are being moved, the patient should be in the recumbent posture so as to avoid strain on the wound.

For a period of three months after operation there should be no hard manual work.

The Johns Hopkins Operation for Hernia.—This operation is the result of the experience and ingenuity of the surgical staff in the Johns Hopkins

Hospital. It is based on the original operation of Halsted, modified by himself and Bloodgood. ("Johns Hopkins Bulletin," August, 1903.)

Step 1.—Divide the skin and the aponeurosis of the external oblique as in the Bassini operation. Reflect the aponeurotic flaps.

Step 2.—Split the cremaster muscle and fascia along a line a little above the centre of the cord.

Step 3.—Expose clearly the internal oblique muscle beside the canal.

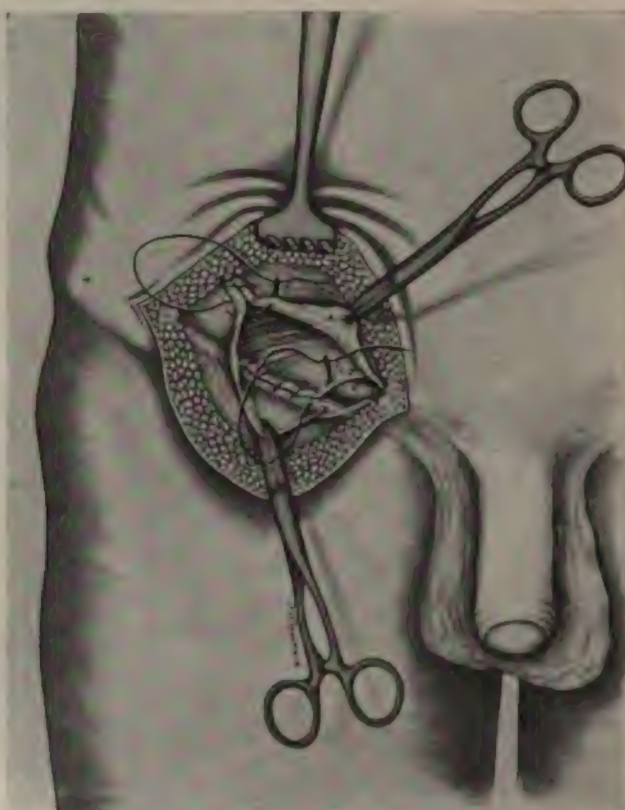

FIG. 705.—(*A. H. Ferguson.*)

Step 4.—Examine the hernia and the cord. If the veins are large, and this is usually the case, excise them with very great care to avoid even the slightest extravasation of blood into the tissues about the smaller veins and about the vas deferens which they accompany. Do *not* raise the vas deferens from its bed; do not handle or even touch it, if possible, lest thrombosis of its veins occur (Fig. 706). Ligate the veins as high up in the abdomen as possible, pulling them quite firmly just before the ligature (in a needle with the blunt end first) is passed between them. Ligate the lower portions of the veins at a point as high above the testicle as possible, the stump being, of course, outside the external abdominal ring.

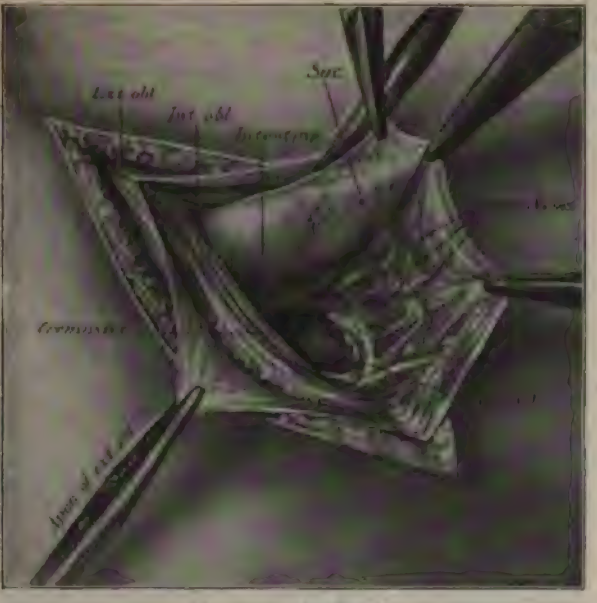

FIG. 706.—(*Halsted.*)

FIG. 707.—(*Halsted.*)

Step 5.—Ligate the sac by transfixion or purse-string suture at the highest possible point. After tying this suture thread its ends on long curved needles and pass them outwards under the internal oblique muscle to penetrate the muscle from within outwards at two points about 5 mm. (1/5 inch) apart. Tie

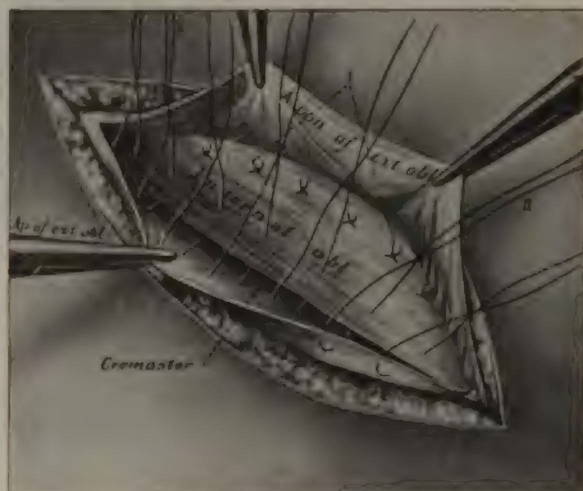

FIG. 708.—(*Halsted.*)

FIG. 709.—(*Halsted.*)

the ligatures. This step dislocates the neck of the sac in a manner essentially the same as is recommended by Kocher.

Step 6.—Draw the lower flap of cremaster muscle and fascia up under the internal oblique muscle, and fix it there by fine sutures which, having engaged firmly a few bundles of the cremaster, perforate the internal oblique, pre-

ferably where it is becoming aponeurotic, and are tied on the external surface of the latter (Fig. 707).

Step 7.—Stitch the internal oblique muscle, mobilized and possibly further

FIG. 710.—(*Halsted.*)

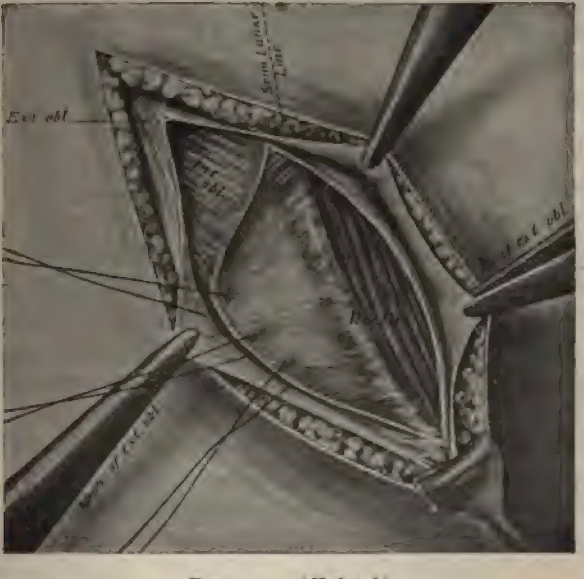

FIG. 711.—(*Halsted.*)

released by incising the anterior sheath of the rectus muscle (along with its conjoined tendon) to Poupart's ligament (Fig. 708). Do this in such a manner that the lower edge of the internal oblique is tucked under Poupart's ligament.

Step 8.—Suture the aponeurotic flaps of the external oblique by the Andrews-Halsted method, which makes them overlap (Figs. 709, 710).

Step 9.—Close the skin-wound.

Where the hernial opening is very large and the conjoined tendon atrophied, a flap of the anterior sheath of the rectus muscle may be reflected outwards and downwards and sutured to the under surface of Poupart's ligament (Fig. 711). This flap of fascia aids in closing the canal by the usual means.

Kirschner ("Archiv für klin. Chir.," xcii, 896) supports the line of suture as follows: Make an incision through the skin of the thigh and expose a sufficient area of fascia lata; *excise* a strip of fascia lata longer than the hernial wound and about two to two and one-half inches wide; spread this "free" fascial flap over the line of suture closing the inguinal canal and suture it there.

In an inguinal hernia which had recurred after operation by two excellent surgeons, the author adopted Kirschner's method with gratifying results. He has found the free transplantation of fascia of much value for many purposes.

Instead of using a flap of rectus sheath to aid in closing the inguinal canal when the conjoined tendon is insufficient, Bloodgood splits the outer margin of the rectus sheath from the pubic insertion upwards for 2 inches (5 cm.). The muscle bulges from the cut and is sutured to Poupart's ligament.

En résumé.—The special features of the Johns Hopkins methods of operating are:

1. Excision of the veins of the cord and avoidance of injury to the vas deferens.
2. Use of the cremaster muscle and fascia to strengthen the closure.
3. Overlapping of the various structures brought into apposition.
4. Reinforcement of the lower part of the wound when necessary by a flap of rectus fascia or by rectus transplantation.

UMBILICAL HERNIA

The classical method of operating in cases of umbilical hernia was to make a vertical incision more or less over the centre of the swelling, open the sac, free the contents, reducing intestine and excising redundant omentum. Ransohoff has shown that much time is lost and danger to viscera incurred by this method of attack, and has laid down the principle that the incision should always be made into the free abdominal cavity at the neck of the sac.

Modified as above, the classical operation may be described as follows:

Step 1.—Make a vertical incision from a point well above the hernia to a similar point below. When passing the hernia, the incision should be deflected to one side or the other of the umbilicus (Fig. 712).

Step 2.—Through the above incision without opening the sac dissect down to and freely expose the aponeurotic structures *at one side* of the neck of the hernia.

Step 3.—Open the sac at its neck; reduce any extruded gut. Ligate and divide redundant omentum and reduce the omental stump. Place a gauze pad against the opening into the abdomen and excise the hernial sac, the remains of omentum which it may contain, and such redundant skin as may require removal.

This excision may be done rapidly, as all danger of injury to gut, etc., has been avoided by its early isolation and reduction.

Step 4.—Close the peritoneal wound by a row of catgut sutures.

Step 5.—By sharp and blunt dissection open the rectus sheath on both sides of the wound and expose the edge of both recti muscles.

Step 6.—Unite the posterior layer of rectus fascia or sheath by sutures. Suture together the rectus muscles. Unite the anterior layer of rectus fascia. Close the skin-wound.

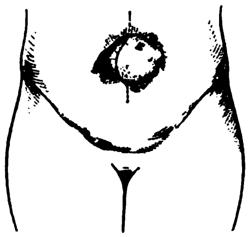

FIG. 712.

The above is a good operation in cases of small hernia; but, as the Mayos have shown, when the hernia is large, and, as is usually the case, the patient is fat, there is a wide separation between the recti and these muscles are themselves atrophied. The classical operation has therefore proved inefficient, in the very cases where success is most to be desired. The Mayos' operation has become *the* recognized procedure. It does not seek to obtain muscular apposition but depends for success on the formation of a strong aponeurotic barrier.

The Mayos' Operation (Figs. 713, 714, 715).—*Step* 1.—Make *transverse* elliptical incisions around the umbilicus and the hernia. Deepen these to the base of the hernial protrusion.

Step 2.—For an inch and a half in all directions from the neck of the sac carefully expose the aponeurotic structures.

Step 3.—Divide, in a circular manner, the fibrous and peritoneal coverings of the hernia at the neck. Expose the hernial contents. If viscera are present, separate the adhesions and reduce. Ligate the contained omentum and remove it with the entire sac of the hernia.

Step 4.—Grasp with forceps and approximate the margins of the ring. In whatever direction overlapping proves easiest lies the proper direction for closure.

Step 5.—Incise the aponeurotic and peritoneal structures of the ring for a distance of one inch or more transversely to each side. Separate the peritoneum from the under surface of the upper of the two flaps thus formed.

Step 6.—Beginning one inch or more above the margin of the upper flap, introduce three or four mattress sutures, the loop firmly grasping the upper margin of the lower flap. Make sufficient traction on these sutures to permit of closure of the peritoneum with a continuous catgut suture. Tie the mattress sutures, sliding or pulling the entire lower aponeurotic flap into the space between the peritoneum and aponeurosis above.

Step 7.—With catgut, suture the lower edge of the upper aponeurotic flap to the aponeurosis below. Close the superficial wound.

Kelly's modification of the Mayos' operation. ("Annals of Surg.," May, 1910.)

Step 1.—Make a curved transverse incision across the hernia from a point slightly external to the right rectus to a point slightly external to the left rectus

muscle. The concavity of the curve is directed upwards. Expose the fascia over both recti.

Step 2.—Divide the fascia over both recti and separate it, from the muscles, upwards and downwards for a distance of 2 or 3 cm. ($\frac{3}{4}$–$1\frac{1}{8}$ inches) so as to form fascial flaps (Fig. 716).

Step 3.—Isolate and open the hernial sac. Treat its contents in the usual fashion.

Step 4.—Close the peritoneal wound with catgut sutures.

FIG. 715.—Mayo's operation. Umbilical hernia. (*Mayo.*)

Step 5.—"Haul up and sew the free margin of the lower under the upper flap from side to side with four to six interrupted silk sutures, using, if needs be, catgut between them. If the transrectal incision is angled a little upwards and the overlapping of the recti is well done, there may be little tension; there is always a greatly diminished tension in the overlapping at the ring itself." Suture the free overhanging margin of the upper flap to the fibrous tissues by a continuous catgut suture.

Step 6.—Close the skin wound.

When a large defect in the abdominal wall cannot be closed in the above

manner or in some modification thereof, closure has been effected by means of a perforated celluloid plate (McCosh) or of a silver wire meshwork (Phelps, Willy Meyer, Bartlett). Meyer and A. E. Barker are very urgent in the praise

FIG. 714.—Mayo's operation. Umbilical hernia. (*Mayo.*)

FIG. 715.—Mayo's operation. Umbilical hernia. (*Mayo.*)

of this method of closure. The meshwork or fence of silver wire seems to be well borne by the tissues and to form the nucleus of a strong mass of connective tissue.

The author has used Bartlett's wire mesh with great satisfaction in a case

of hernia resulting from loss of much of the upper end of the right rectus abdominis muscle. Kirschner's plan (p. 612) of the "free" transplantation of a flap of fascia lata may possibly supplant the use of foreign materials.

Ventral herniæ of all varieties are to be treated on the same principles as are advocated for umbilical herniæ. Undoubtedly the best treatment for post-operative ventral herniæ is, to use an Irishism, not to have them. For this purpose nothing is better than attention to cleanliness, careful closure of the parietes in their anatomic layers, and absolute avoidance of strain until the embryonic tissues necessary for the repair of abdominal wounds have had time to become mature.

Rutherford Morison's Operation.—(1) Make long transverse incisions including the hernia in an ellipse. (2) Expose the rectus sheath above, below and

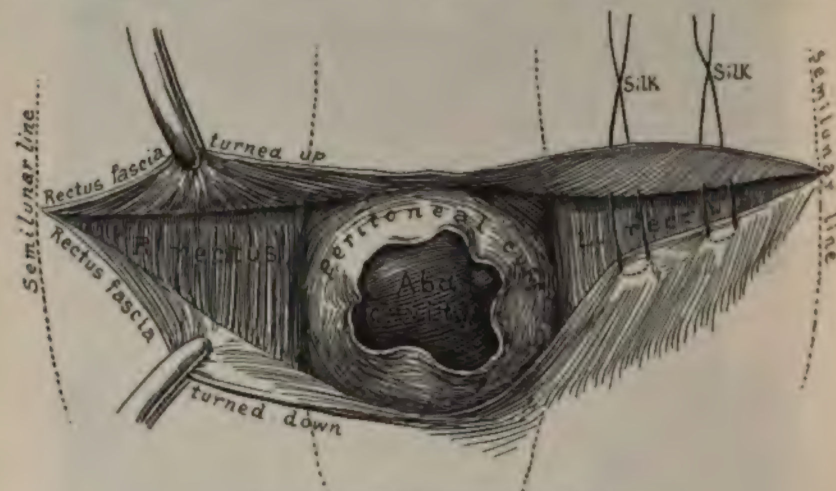

FIG. 716.—Umbilical hernia. (*Kelly.*)

on each side of the hernia. (3) Open the sac and the abdomen through the linea alba below the hernia. (4) Reduce the hernial contents, never cutting away omentum unless absolutely necessary. Cut away sac. (5) With fingers in the abdomen introduce thick catgut mattress sutures through the aponeurosis and rectus muscle on either side but do *not* tighten them. Separate and hold up the mattress sutures so as to expose the peritoneal wound. Suture the peritoneal wound. Infold the aponeurosis by tightening and tying the mattress sutures, making a keel towards the abdominal cavity and bringing broad surfaces of aponeurosis into apposition. Draw surfaces of aponeurosis still more together by thick interrupted catgut sutures above, below and between the mattress sutures. (6) Drain cavity with a tube introduced by small incision through the *upper* flap. (The skin of the lower flap is often moist and infected.) (7) Apply dressings and support the abdomen with adhesive straps.

Wullstein's operation for ventral hernia is sufficiently described by Fig. 717. (Zentralblatt für Chir., Sept. 22, 1906, p. 153.)

When a patient with umbilical hernia is atrociously fat it is often wise to operate as follows:

1. Make a transverse curved incision across the abdomen a short distance above the hernia. Make a similar incision, beginning and ending at the same points, below the hernia running in the fold between the pendulous abdominal fat and the supra-pubic region. Incise deeply enough to expose the aponeurosis.

2. Through both incisions separate the fat from the aponeurosis towards the hernia. When the neck of the hernial sac is exposed open it and treat its contents as described in Step 3 of the classical operation (page 612). Remove the skin and fat included between the primary incision. Complete the operation by the Mayo method.

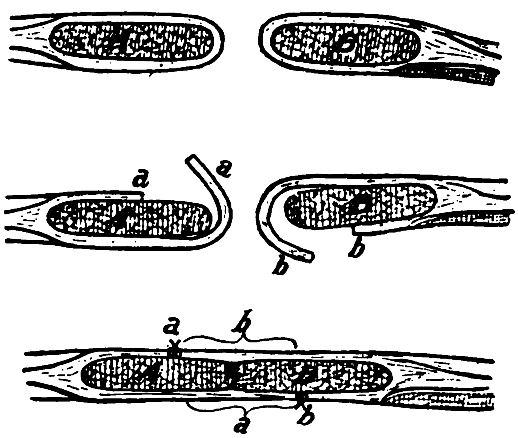

FIG. 717.—Wullstein's operation for ventral hernia.

Congenital eventration or evisceration is an extremely fatal deformity. The difficulty in replacing the viscera is due to the fact that the usual infantile "pot bell" is absent, the recti muscles pass straight down from costal margin to pubis; the intestines, though distended with meconinm, not having pushed them forwards in the usual fashion.

Charles G. Mixter has operated (personal communication) as follows: If the prolapsed viscera are covered with peritoneum excise this but leave a margin of peritoneum ½ inch wide around the opening at the umbilicus. Enlarge the hernial opening by a transverse incision on each side. Lift up the lower margin of the wound so as to expose the peritoneal surface of the lower anterior abdominal wall. Working from the inside of the abdomen make a transverse incision from the middle line outwards to the flank dividing all the structures of the abdominal wall except the skin and superficial fascia. Make a corresponding incision at a slightly different level on the opposite side of the lower abdomen. Make similar incisions in the upper part of the abdominal wall. Attend to hemostasis. Empty the bowel by multiple punctures and replace it in the abdomen. Close the wound.

CHAPTER XLVI

RETRO-PERITONEAL, LARGE AND DIAPHRAGMATIC HERNIA

RETRO-PERITONEAL OR INTERNAL HERNIA

Normally the peritoneal cavity is provided with a number of apertures or fossæ which, under ordinary circumstances, are entirely harmless, but which may become dangerous owing to various anomalies of development and to adverse circumstances. The following are the most important of these structures:

1. The foramen of Winslow. In a few cases small intestine has entered the lesser peritoneal sac through this opening. The condition, if found during life, demands that the herniated intestine be reduced into its proper location and that the foramen be lessened in size or obliterated. Probably the trauma due to the hernia and its reduction will produce enough plastic peritonitis to effect obliteration; a gauze or cigarette pack introduced into the foramen would act similarly, or one or two catgut sutures may be judiciously introduced.

2. Recessus duodenojejunalis. At the point where the duodenum passes into the jejunum a fold of peritoneum, containing the inferior mesenteric vein, forms a semilunar opening to the left of the origin of the jejunum (Fig. 718). Usually this opening or recess is shallow and not wider than a man's thumb. Jonnesco and others have described several varieties of recess in this situation, but for our purposes the recognition of its existence and of its proneness to vary, suffices. Intestine may bore its way into the recess described, enlarging the opening and forming a retroperitoneal hernia (Treitz's hernia). The pouch formed by the herniated gut may stretch to the left under the descending colon and downwards to the pelvis. Upwards the hernia may pass under the root of the transverse mesocolon to a position behind the stomach and spleen. Strangulation is rare. It is commonly supposed that small intestine alone is involved, but Freeman ("Transactions American Surg. Assoc.," 1903) describes a case in which the sac contained the entire small intestine, the cæcum and a portion of the colon, which was strangulated. A. Narath ("Archiv f. klin. Chir.," lxxi, 911) reports a case in which prior to operation the diagnosis was pyloric or gall-bladder tumor. When the abdomen was opened above the umbilicus, the small intestines presented *in front* of the great omentum, the transverse colon, and the stomach. When the small intestine was pulled out of the belly cavity for inspection, the cæcum and vermiform appendix followed, appearing *above* the lesser curvature of the stomach. The case was one of hernia through the recessus duodenojejunalis; the gut passed up behind the stomach

and then forwards through the gastro-hepatic omentum. Reduction was easy, and the duodenojejunal opening was closed by a few stitches of catgut.*

3. Pericæcal fossæ. Three fossæ exist in the neighborhood of the ileo-cæcal junction (Fig. 719): (*a*) Ileo-colic fossa, which lies above the ileum and below the ileo-colic fold containing the colic branch of the ileo-colic artery. (*b*) Ileo-cæcal fossa. The orifice of this fossa is situated below the ileum, where it joins the cæcum. The fossa may be large and extend upwards posterior to ascending colon as far as the right kidney. (*c*) Subcæcal fossa. This fossa lies beneath the cæcum and external to the meso-appendix and meso-cæcum. Any one of the pericæcal fossæ may be the site of an internal hernia, especially if its

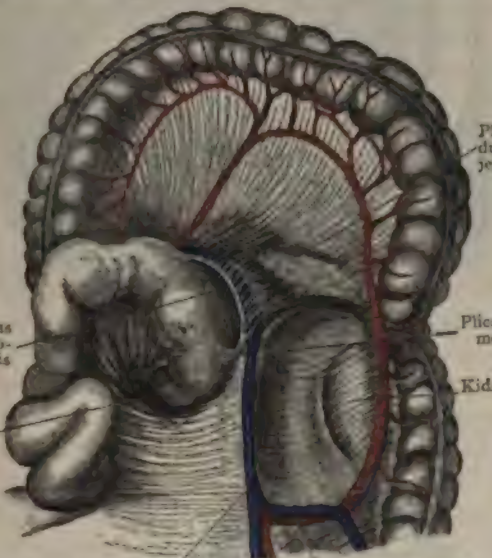

FIG. 718.—(*Zuckerkandl.*)

normal relations have been altered by attacks of appendicitis. The fossæ are also of surgical importance, as they may be filled with the products of inflammation in appendicitis, and into one of them the appendix itself may be herniated.

4. The intersigmoid fossa (Fig. 720). On the lower or left surface of the meso-sigmoid a fossa may exist which is variable in size. A few cases of hernia have been described in which this fossa formed the sac.

Many operations have been undertaken for the treatment of obscure intestinal obstruction, chronic or acute, and in many of these, symptomatic recovery has ensued, although no cause was discovered during the operation. Undoubtedly in many of these cases an internal hernia has been overlooked or has been reduced, unknown to the operator, by the manipulations necessary in exploration.

* For extended information on this subject the reader is referred to Freeman's paper already mentioned, to Moynihan's work, "Retroperitoneal Hernia," London, 1906, to Jonnesco's "Hernies internes rétro-peritonéales," Paris, 1890. Vautrin, "Les Hernies Paraduodenales," Rev. de Chir., Jan., 1907.

This short chapter has been written to direct the attention of the junior surgeon to the probable sites of internal herniæ. The author believes that internal herniæ are very much more common than statistics would indicate.

LARGE HERNIA

Occasionally herniæ become so large and contain so many organs that

FIG. 719.—(*Zuckerkandl.*)

FIG. 720.—(*Zuckerkandl.*)

these organs may be said to have lost their right of domicile in the abdomen, and hence reduction, whether operative or non-operative, becomes impossible or unjustifiable. In other cases adhesions uniting the hernial contents to each other and to the sac constitute a condition which, either alone or in

ombination with a poor state of the general health, contraindicate any attempt t reduction. In such cases when strangulation or obstruction becomes evi- ent, what means have we to overcome their disastrous results?

If the strangulation is due to constriction at the hernial orifice, common ense tells us to divide the constriction by free, open incision, and, contrary to he practice in "radical cure," to endeavor to retain the increased patency of he opening between the abdominal cavity and the hernial sac. In other words, our aim ought to be to make the abdominal cavity and hernial sac as nearly as possible one.

Usually in large herniæ nature has so dilated the abdominal orifice that strangulation at this point is rare. It is more common to find that adhesions, bands, diverticula, etc., in the hernial sac itself are the cause of strangulation. As Madelung ("Archiv. f. klin. Chir.," lxxiv, 60) points out, gangrene may be far advanced in herniæ of this class, and symptoms be almost absent; thus during operation one may be compelled to excise a considerable amount of diseased gut, joining the afferent and efferent sections by anastomosis or enterorrhaphy, or may establish a fæcal fistula. Some surgeons have, on general principles, excised a mass of herniated gut, so that reduction of the remainder became possible and a radical cure could be effected.

In very large herniæ there is always some obstruction to the onward passage of fæces; this obstruction varies from time to time. Mild exacerbations are usually successfully treated by purgation, enemata, rest in bed, massage, etc., but occasionally operative interference becomes necessary. Madelung writes: "In many cases, especially the old and feeble, when coprostasis has continued for a long time, it is very proper to establish a fistula in the afferent gut. Under local anesthesia this is absolutely without danger even in the most debilitated. The fistula should be small, about the size of a medium-sized Paquelin cautery point. It should drain only part of the intestinal contents, acting as a kind of safety-valve." When the patient is strong enough to withstand a more severe operation, intra-abdominal anastomosis between the afferent and efferent loops of gut serves to segregate or exclude the affected viscera (see "Intestinal Exclusion"). It is, of course, impossible to formulate precise rules for the operative treatment of irreducible herniæ, but it is hoped the above brief remarks may aid the inexperienced practitioner in an emergency.

DIAPHRAGMATIC HERNIA

The diaphragm is the site of several actual or potential openings, the principal one being that between the costal and sternal origins of the muscle and known as the foramen of Morgagni. Hernia through Morgagni's foramen is known as parasternal hernia, and is provided with a double sac, of pleura and peritoneum. For our purpose it is useless to differentiate between the so-called true hernia and the false, where, owing to injury, there is a prolapse of abdominal [illegible] into the thorax. Very few diaphragmatic herniæ have been diagnosed; [illegible] discovered during operation or autopsy. The commonest

cause of diaphragmatic hernia is trauma, usually from knife or bullet, and the proper treatment is immediate operation. In Lacher's statistics of 36 traumatic cases not submitted to operation, 15 died from hernia after periods varying from a few days to a month, and 10 died in from five to twenty years from the same cause. A wound of the diaphragm when left to itself may heal, but the scar remains weak and hernia is the common result. This being true, the best treatment for traumatic diaphragmatic hernia is prophylactic. The wound of entrance is almost always in the thorax. Enlarge the wound, excise two inches or more of one or two ribs, as may be required, to give room. Note if the pleura is or is not injured. In a case operated on by the writer the pleura was uninjured, though the diaphragm was penetrated and omentum was present in the thorax. Expose and examine the diaphragm. If the diaphragm has been penetrated and omentum or hollow viscera present, examine and repair any injury they may have sustained. Open the abdomen either by a median or lateral incision, or, as Neugebauer ("Archiv f. klin. Chir.," lxxiii, 1014) did, by a cut dividing the costal arch. It is usually easier to reduce the prolapsed organs after the abdomen has been opened, and it is necessary to explore the abdomen in search for further injuries. If no abdominal contents are prolapsed through the diaphragmatic wound, open the abdomen and search for any injuries to its contents. If the liver is injured, treat such injuries *secundem artem*. Close the wound in the diaphragm with sutures introduced by the transthoracic route. Close the wound in the abdomen and thorax with or without drainage. In 52 cases of diaphragmatic suture (where there was no *strangulated hernia*) the mortality was 9.6 per cent. when the transthoracic route was adopted; in 10 similar cases when the abdominal route was used the mortality was 50 per cent. Of the cases of strangulated diaphragmatic hernia collected by Neugebauer, all those operated on through the abdominal route died; one out of two operated on through the thorax lived. Two cases of non-strangulated diaphragmatic hernia submitted to radical cure (Llobet's and Cranwell's) lived after a transthoracic operation.

Donald Balfour (personal communication) has operated successfully by the abdominal route.

When operation is performed for obscure abdominal lesions, one ought to remember and look for diaphragmatic hernia, and if such is found, one ought *not* to waste time endeavoring to reduce it from the abdominal side, but proceed at once to open the chest. Suture of the diaphragm from below is extremely difficult and necessitates very much disturbance in a region rich in important nerves. Prolapsed masses which it is impossible to reduce from the abdomen alone are easily reduced or slip back of themselves as soon as the chest is well opened. That the dangers from pneumothorax are not so great as is usually imagined is shown by the small mortality (9.6 per cent.) after recent wounds of the thorax. Furthermore, if the hernia is reduced through the abdominal route, pneumothorax must occur immediately the hernia ceases to plug the diaphragmatic wound, while the establishment of pneumothorax prior to reduction aids marvelously in obtaining this reduction.

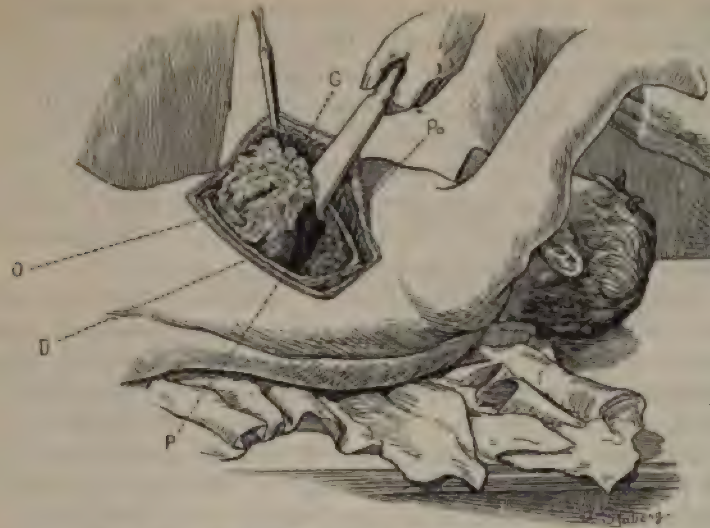

FIG. 721.—Cranwell's operation for diaphragmatic hernia.
P. Pleura. *D.* Diaphragm. *O.* Omentum *C.* Colon.

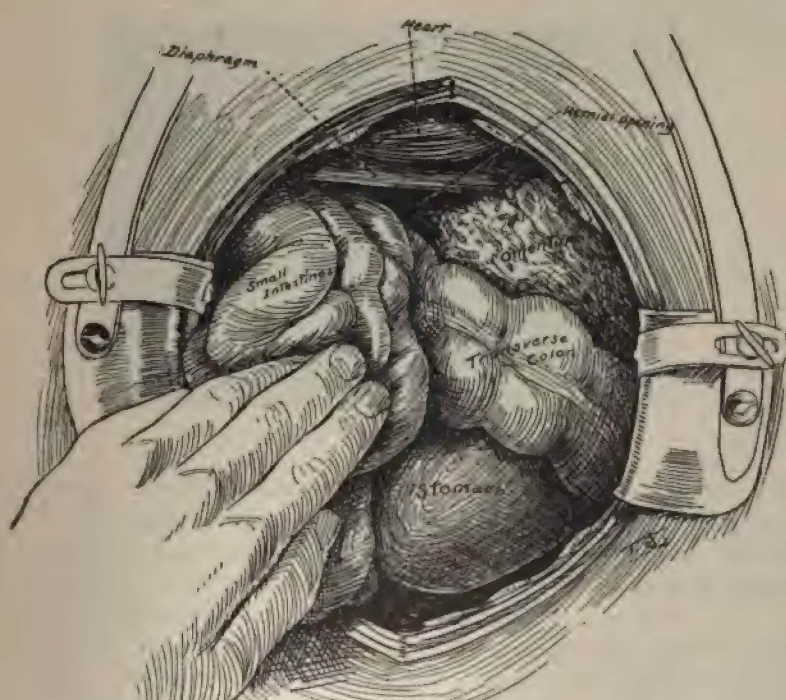

FIG. 722.—(*Carson, Interstate Med. Journ.*)

Cranwell ("Rev. de Chir.," Jan., 1908) recognized the presence of a diaphragmatic hernia before he operated. His patient was placed on his side in the reversed Trendelenburg posture. The lower and lateral part of the thorax was opened by a flap having its base above, consisting of the whole thickness of the chest-wall and containing about 5 inches of the ninth and eighth ribs (Fig. 656). In spite of numerous adhesions the prolapsed omentum and colon were reduced, the openings in the diaphragm and in the pleura were sutured and the external wound closed. The patient recovered. The hernia was due to an old stab-wound which had healed.

N. B. Carson ("Interstate Med. Journ.," April, 1912) reports a successful operation for diaphragmatic hernia (supposed to be of congenital origin), in which a correct diagnosis was made prior to operation. Insufflation anesthesia was used and the intrathoracic structures were prevented from drying by being smeared with vaseline. The use of Carrel's vaselinized silk napkins to protect the lungs, etc., was found impracticable. It was necessary to resect several ribs before proper access was obtained. Fig. 722 shows the exposure of the hernia which consisted of small intestines, stomach, colon and omentum. Reduction was effected only after the abdomen was also opened. After suture of the diaphragm the wound in the chest wall was closed in layers, but before closing, the pressure was raised and the lung fully expanded.

PART IV.—THE GENITO-URINARY SYSTEM

CHAPTER XLVII

OPERATIONS UPON THE KIDNEY

METHODS OF EXPOSING THE KIDNEY

I. Posterior or Lumbar Route.—There are two positions in which the patient may be placed:

(*a*) The classical or lateral posture. Place the patient upon his sound side with his back near the edge of the operating table and his thighs and knees well flexed. To increase the space between the thorax and ilium, place a roll-shaped, firm pillow under the loin of the sound side. The surgeon stands at the patient's back.

(*b*) The prone position. This position is the best for most purposes. Lay the patient prone upon the table. Place a large pillow (Edebohls' air-cushion,

FIG. 723.—(*Edebohls, Annals of Surg.*)

12 inches long by 8 inches in diameter, is excellent) beneath his abdomen with its long axis at right angles to the long axis of the body. This lifts the kidneys into the field of operation and gives the widest possible costo-iliac space. The operating table referred to as suitable in operations on the bile ducts is of value here to replace sand-bags and cushions (see p. 560).

(A) *Vertical Incision* (Simon).—Recognize the last rib and the erector spinæ muscle. Make a vertical incision from the last rib downwards, parallel and close to the outer edge of the erector spinæ muscle. This penetrates the skin and subcutaneous tissue and extends nearly to the crest of the ilium. The

latissimus dorsi is now seen. *Separate* but do not cut its muscular fibres (Figs. 723 and 724). The erector spinæ muscle presents. Retract it inward, but do not open its sheath. Expose and open the sheath of the quadratus lumborum along its outer margin for the full length of the wound. As the pleura occasionally extends below the last rib, it is wise to avoid the neighborhood of this rib while making deep dissection. By keeping one inch below the rib, all danger to the pleura is avoided and at a little later period in the operation the wound can be safely enlarged upwards under guidance of the finger. As soon as the fascia lumborum or transversalis fascia, lying in front of the quadratus lumborum, is divided, perirenal fat bulges into the wound. Remember that the last thoracic, iliohypogastric, and ilio-inguinal nerves lie between the quadratus muscle and the kidney. These nerves, when met with, should be carefully pulled aside, or if it is necessary to divide one of them, the severed ends ought to be caught up in a suture, so that when the operation is completed and the wound is being closed, they may be once more united (Edebohls). Failure to attend to this point may lead to an annoying and persistent pain in the thigh after operation. When the perirenal fat is exposed, tear through it and expose the kidney.

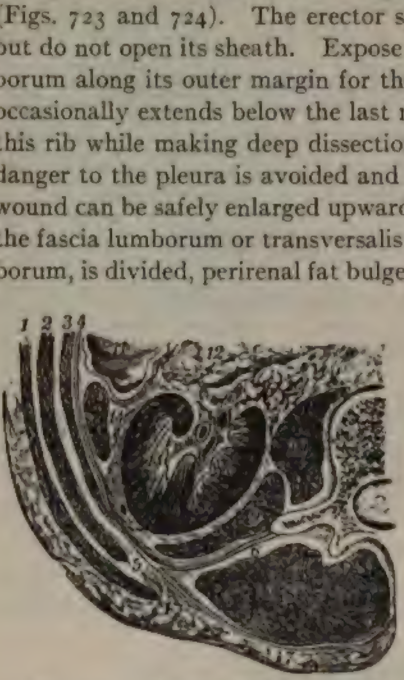

FIG. 724.—(*Esmarch and Kowalzig.*)

1. External oblique. 2. Internal oblique. 3. Transversalis. 4. Transversalis fascia. 5, 6, 7. Lumbo-dorsal fascia. 8. Sacrospinalis. 9. Quadratus lumborum. 10. Psoas. 11. Colon. 12. Pancreas. 13. Kidney. 14. Spleen.

If the above incision does not give sufficient room, make a small transverse incision through the outer fibres of the quadratus muscle near the ilium; this simple proceeding is of great aid. To gain more room, some surgeons have recommended excision of the last rib, but this has not proved of much value. A better suggestion has been made, namely, to fracture the last rib and turn it upwards. It is easy to deliver the kidney on to the back through this incision.

(B) *Oblique Incision* (Bergmann).—From the outer edge of the erector spinæ, at the level of the twelfth rib, make an incision downwards and outwards towards the junction of the outer and middle thirds of Poupart's ligament. The length of the incision varies with the work to be done and the size of the operator's hand. It must be large enough to give free access to the kidney. A cut four inches in length is generally sufficient for exploratory purposes and may readily be enlarged. The lower border of the latissimus dorsi presents and must be divided. Layer by layer cut through the external oblique, the internal oblique, the transversalis muscle. Under the last-named muscle lies the transversalis fascia. Make a small opening in the fascia and, guided by the finger passed through the opening, divide it for the whole length of the wound. The quadratus lumborum lies at the upper and inner part of the wound and is either retracted towards the spine or divided, as may be convenient. After division

of the transversalis fascia the perirenal fat presents and is torn through until the kidney is reached. During the deeper dissection care must be taken not to injure the pleura should it descend below the last rib.

(C) *Triangular Incision* (König).—From the outer edge of the erector spinæ, at the level of the twelfth rib, cut downwards parallel and close to the erector muscle until the iliac crest is reached. From the lower end of the wound make a curved incision directed towards the navel and reaching to the outer margin of the rectus abdominalis. The division of the deeper structures is carried out in the manner already described. Any parietal peritoneum which may be exposed is pushed aside. Very free access to the kidney or to tumors of that organ is attained.

(D) *Zuckerkandl's Incision.*—From the outer edge of the erector spinæ, at the level of the twelfth rib, cut downwards to the middle of the iliac crest; from the latter point cut forwards to near the anterior superior spine of the ilium. The deep dissection is done as already described.

FIG. 725.—(*Mayo.*)

(E) *Trap-door Incision* (Bardenheuer).—From the upper and lower extremities of the vertical incision (A) make horizontal cuts parallel to the lower edge of the thorax and to the iliac crest respectively. If these cuts run forwards, a trap-door is formed which can be reflected or retracted anteriorly; if they run backwards (*i.e.*, towards the spine), one which can be turned backwards is the result. In some cases it may be desirable to form both an anterior and a posterior trap-door flap.

Should the peritoneum be opened during the operation, it ought to be closed at once by suitable sutures.

(F) *C. T. Parkes' Incision.*—Make a curved incision from a point two inches above the anterior superior spine to the tip of the last rib. Expose the fascia transversalis. With the finger dissect well behind the tumor of the kidney. Having separated all the parts, make a straight incision backwards from the first cut and half-way between the crest of the ilium and the last rib. An excellent exposure is obtained of the kidney, vessels, and ureter.

(G) Mayo's Incision.—("Annals Surg.," Jan., 1912.)

Step 1.—From a point 2 to 2½ inches external to the dorsal spines near the outer margin of the erector spinæ over the twelfth rib, or even higher, make an incision downwards and forwards along the anterior margin of the quadratus lumborum to a point about 1 inch above the crest of the ilium (Fig. 725). From this low point continue the incision forward parallel to the iliac crest as far as necessary. Divide the skin, superficial fascia and posterior layer of the lumbodorsal fascia which covers the erector spinæ muscle.

Step 2.—Expose the posterior superior lumbar triangle just beneath the

twelfth rib by cutting an opening through the external and internal oblique, transversalis and latissimus dorsi muscles. Open the transversalis fascia freely and so expose the perirenal fat. Clear the twelfth rib in its posterior aspect, upwards and backwards nearly to its articulation. Push the pleura upwards. Retract the rib upwards and the erector spinæ backwards (Fig. 726). This gives remarkably good exposure and very much simplifies all operations on the kidney possible through the lumbar route. If necessary the twelfth rib may be dislocated or fractured to permit even greater exposure.

Fig. 726.—(*Mayo.*)

II. Anterior or Abdominal Route.—If the kidney to be exposed is *very* large, an incision may be made over the tumor at any place which may seem suitable or advisable. Such an incision will be either vertical or oblique (running from above downwards and inwards). Langenbuch's incision will generally be found to be the best, as it gives free access to the renal vessels and avoids unnecessary exposure of the intestines. Küster makes it a rule to operate by the transperitoneal route in cases of neoplasm when difficulties and adhesions are present; if the tumor is very mobile he chooses the lumbar route.

Langenbuch's Method.—Form a point immediately below the ribs and about three inches from the middle line cut downwards for a distance of four inches.

Find the outer edge of the rectus muscle (linea semilunaris). Cut down to the peritoneum, following the semilunar line. Open the peritoneum carefully in the same manner as a sac is opened during a herniotomy. Introduce the hand and examine the opposite kidney and ureter. This is a most important precaution, and must always be observed. The opportunity afforded to examine the opposite kidney constitutes one of the advantages of the abdominal route over the lumbar. Von Eiselsberg convinced himself by touch (of the hand in the abdomen) that the second kidney was present, yet after nephrectomy the patient died from uremia. Autopsy showed absence of the other kidney, the surgeon having taken an induration of the pancreas to be a kidney. The opposite kidney and ureter being found healthy, the intestines are covered with a large flat gauze pad and kept out of the way. The outer surface of the mesocolon is exposed and a small hole made in its outer layer. This hole is enlarged by tearing. The vessels which pass through the mesocolon lie close to its inner layer, and thus injury to them is avoided. Through the opening in the mesocolon the kidney is easily and completely exposed.

Rutherford Morison's Incision.—Open the abdomen through the rectus muscle. Make a transverse incision from this back to the centre of the iliocostal space. Morison writes: "This allows pus to escape behind and away from the peritoneum, perfect drainage after, and good access to vessels and ureter during operation." It also permits exploration of the opposite kidney at the beginning of the operation.

Nephropexy or Nephrorrhaphy.—*Method I.*—Expose the kidney by incision A or B. Excise most of the fatty capsule lying posterior to the kidney. An assistant with his fist pressing on the belly pushes the kidney up into the loin. Pass a curved needle, armed with a thick suture, through the muscles and fascia of the back which form the outer edge of the wound, through the remnants of the fatty capsule and into the kidney parenchyma near the outer convex border of the kidney. The needle penetrates the kidney to a depth of about one-half inch and emerges at a point about three-quarters of an inch internal to its point of entrance. After emerging from the kidney the needle passes through the remnants of the fatty capsule and the muscles and fascia of the back which form the inner edge of the wound. Three such sutures are put in place, one at the upper end of the kidney, one at the lower, and one in the middle; but none of them are tied. The deep parts of the wound in the back are now approximated by buried sutures. When this is done, the three sutures which pass through the kidney are *carefully* tied. No pulling upon these important sutures is allowable, otherwise they would cut their way out of the friable kidney. This is the reason for closing the deep parts of the lumbar wound (*i.e.*, the parts through which the kidney sutures pass) before the kidney sutures themselves are tied. The superficial wound is closed. Some surgeons, notably Newman, pass a drainage-tube through the wound to the kidney so as to produce a local irritation and thus aid in the formation of adhesions. *Suture materials:* Mildly chromicized catgut, kangaroo tendon, silk or silkworm-gut.

Method II.—Is the same as Method I, except in one particular: After

the kidney is exposed a longitudinal incision is made through the fibrous capsule, which when turned outwards and inwards like the lapels of a coat, forms an outer and an inner flap. The parenchyma of the kidney is thus left exposed for a width of about three-quarters of an inch throughout almost the whole length of the posterior surface of the organ. The sutures are introduced as before, except that when entering and leaving the kidney they pass through the folded flaps of fibrous capsule.

The advantages claimed for this method are (*a*) that better union takes place between the kidney and the muscles and fascia at the back; (*b*) that the threads passing through the folded back flaps of fibrous capsule are less liable to cut their way out. The objections urged against the method (especially by Albarran) are (*a*) that decortication is unnecessary; (*b*) that sclerotic changes are more liable to occur and injure the kidney.

Method III.—The kidney is exposed by incision B. At a point opposite the lower extremity of the kidney (when it is pushed up into its normal position) a pocket is formed by separating the transversalis fascia from the more superficial structures. Into this pocket the lower end of the kidney is snugly tucked. One or two sutures unite the kidney to the surrounding muscles and fascia and the wound is closed. Pean is a supporter of the above operation.

FIG. 727.—Israel's nephropexy.

Method IV (Israel's).—Expose kidney by incision A. Recognize the last rib. Split the fibrous capsule of the kidney so as to lay bare a narrow strip of cortex reaching nearly the whole length of the organ. Through the upper part of the posterior surface of the kidney pass a *double* suture of thick catgut (Fig. 727, A A¹, a a¹). Cut the loop of the suture so as to leave four ends of suture on which needles are to be threaded. Make a knot on the double thread of catgut where it enters and where it leaves the kidney (z–z). One of the threads emerging from the outermost part of the kidney, having been armed with a needle, is passed, first, through the fatty capsule of the kidney, and then between the periosteum and the posterior surface of the twelfth rib (Fig. 727, A A¹). The other end of thread emerging from the kidney at the same point is passed subperiosteally in front of the twelfth rib in such a manner that the two ends surround the rib under its periosteum. The two threads are knotted together. The two ends of the catgut threads which emerge from the inner part of the posterior surface of the kidney (a a¹) are separately passed through the fatty capsule, and the muscles and fascia on the inner side of the lumbar wound. These two ends of suture are now tied together, care being taken not to tie so tightly as to make the thread cut through the renal tissue. The result of the above manœuvre is to sling the kidney by a double thread the

end of which surrounds (subperiosteally) the twelfth rib; the inner end ened to the muscles and fascia forming the inner wall of the lumbar . Two more double catgut sutures are passed through the kidney in me manner and their loops cut so that each double suture becomes two t sutures passing through the kidney together. The ends of suture ng from the inner part of the kidney are each separately passed through iscles and fascia on the inner side of the wound (B B¹, C C¹) and there gether; those emerging from the outer part of the kidney are similarly through the muscles and fascia on the outer side of the wound b b¹) and there tied. The threads emerging on the inner side are tied er; *none* are tied across the wound. The lumbar wound is closed by nd superficial sutures.

thod V (Jonnesco's Operation).—*Step* A.—Beginning at the outer edge erector spinæ muscles, make an incision from four to five inches along the r border of the twelfth rib. If the h rib is short, the incision is continued the eleventh rib. Expose the whole twelfth and if necessary part of the th rib. Cut through the transversalis and expose the kidney, which an as- t presses up into the wound. Excise of the fatty capsule. Split the fibrous e of the kidney longitudinally and turn rds and inwards an outer and an inner ar flap (as in Method II).

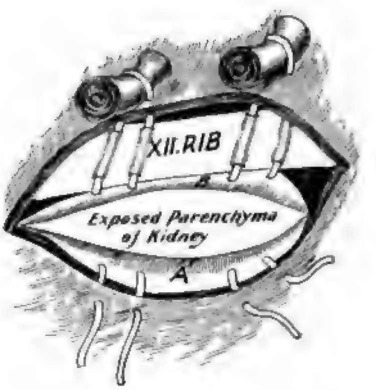

FIG. 728.—Jonnesco's nephropexy.

p B.—Pass a curved needle (Emmet's) through the following structures in der named—the skin (one inch distant the lower edge of the wound), muscles ro-lumbar mass, deep aponeurosis, folded inner flap of renal capsule d in Step A), the kidney parenchyma, the folded outer flap of renal e, the periosteum of the external surface of the twelfth or eleventh rib, he muscles and skin of the superior edge of the wound (Fig. 663). 1 into the needle the end of a silver wire suture; withdraw the needle. oduce the needle in the same manner at a point ½ inch distant and pull h the other end of the silver wire suture. The result is that a **U** suture place. Two such suffice. Through the loop of each **U** is placed a small pad of gauze to prevent the skin being cut. The other ends of each ire are twisted together over a pad of gauze. No tension is put on the s lest they cut the kidney tissue; their function is to suspend the kidney.

p C.—Close the wound with catgut or silkworm-gut sutures.

e dressings are left untouched for ten days, after which time all the **sorbable** sutures are removed.

thod VI (Edebohls' Operation).—*Step* 1.—Expose the kidney by Method **ient being in** prone position.

Step 2.—Deliver the kidney through the wound and excise the fatty capsule.

Step 3.—Decapsulate the kidney and introduce suspension sutures of forty-day chromic gut, as shown in Fig. 729.

FIG. 729.—Edebohls' nephropexy. (*Edebohls, Annals of Surg.*)

Step 4.—Reduce the kidney and pass the sutures from within outwards through the whole thickness of the parietes except the skin, and tie them as in Fig. 730.

Step 5.—Close the lumbar wound.

In performing this operation do not endeavor to anchor the kidney at as high a level as its normal site, and be careful not to cause any kinking of the

FIG. 730.—Edebohls' nephropexy. (*Edebohls, Annals of Surg.*)

ureter. The main principle of the operation is to bring a large area of decorticated kidney into contact with a corresponding area of the quadratus muscle denuded of its fascial coverings.

Method VII.—Albarran ("La Presse Medicale," 21 Aug., 1906) considers that a good operation must fulfill the following conditions: (1) Permit exploration of the kidney and ureter. (2) Place the kidney in good position. (3) Fix the kidney thoroughly. (4) Injure the parenchyma as little as possible.

The Operation.—Step 1.—Expose the kidney by Method B. In tearing through the perirenal fat it is not necessary to remove any of it, but when retracting the fat from the lower pole of the kidney an incision through it at right angles to the original wound is of great service.

Step 2.—Deliver the kidney on to the back. Explore it by sight and palpation. Gross changes are easily made out. When there is slight hydronephrosis the kidney is not so firm as usual, and it is easy to bend it a little on itself, which is impossible in the normal organ. Examine the upper end of the ureter lest kinks or bends are present or lest fibrous bands cause obstruction. Correct abnormalities.

FIG. 731.—Albarran's nephropexy. (*La Pr. Med.*)

Step 3.—Decorticate the kidney completely, making the reflected true capsule form two flaps (anterior and posterior).

Step 4.—Divide the anterior flap into two parts (upper and lower) (Fig. 731). Ligate each of these parts with strong chromicized catgut (Fig. 732), leaving both ends of the catgut long. Treat the posterior capsular flap in the same manner.

Step 5.—Retract the lumbar muscles inwards and expose the twelfth rib. With a needle draw one end of each of the ligatures attached to the upper portions of the capsule round the rib and tie it to the same end of the other ligature (Fig. 732). This suspends the upper pole of the kidney to the rib. One-third of the long diameter of the kidney ought to be now hidden by the ribs. If

it is impossible to pass the sutures round the twelfth rib, fix them to the *external* periosteum of the eleventh rib and to the costo-vertebral ligament. Before tying the sutures see that the kidney is so placed that the ureter is free from kinks and will drain the lowest point of the pelvis.

Step 6.—Fix the ligatures attached to the lower portions of the capsule to the muscles on each side of the wound. Fig. 733 explains this step.

Step 7.—Provide for drainage—close the wound with sutures.

In all the preceding methods of nephropexy the aim of the surgeon has been to suture or sling the kidney to the posterior parietes. Harris has shown that in cases of mobile kidney there is a separation of the posterior peritoneum from the parietes, and that the attachments of the ascending mesocolon are

FIG. 732.—Albarran's nephropexy. (*La Pr. Med.*)

loosened. The result is an absence of normal support to the kidney and the presence of ptosis of the ascending colon.

Harris' Operation.—Place the patient in the prone position; expose the kidney and bring it out through the wound. Retract the edges of the wound and observe the post-peritoneal cavity into which the kidney has been in the habit of gliding and note the position of the ascending colon. By a few carefully placed catgut sutures obliterate the above-named space, and the essential element of the Harris operation is completed. Prepare the kidney for suture, reduce it, and fix it to the parietes by one of the methods already described.

The Harris operation is the only one in which any attention is paid to the fact that nephroptosis is often merely one part of a condition of general visceral ptosis, and in which an endeavor is made to correct part of the visceral ptosis

by fixation of the colon (colopexy) while the post-peritoneal space is being obliterated.

Mobile kidney is exceedingly common, and in the majority of cases presents no symptoms. When symptoms are present, they may be really those of neurasthenia, in which case fixation of the kidney can scarcely be expected to do more than give mental relief. Of course, cases do occur in which the mobility of the kidney is the causative factor, where tension exerted on the structures at the hilus gives rise to trouble and where kinking or displace-

FIG. 733.—Albarran's nephropexy. (*La Pr. Med.*)

ments of the ureter occasion distressing symptoms and conditions. It is in this comparatively small class of cases that nephrorrhaphy gives gratifying results.

G. Percival Mills (Proc. Royal Soc. of Med., Feb., 1914, Surg. Sect.) reviewed all the cases of nephropexy performed in the General Hospital, Birmingham, during 1909–1912, and came to the following conclusions which support the opinions expressed by the author in the preceding paragraph:

1. "The general results of the operation of nephropexy are bad.

2. Nephropexy has very frequently been performed to relieve symptoms that are not due to the movable kidney; this is proved by the persistence of the symptoms after a successful operation.

3. The symptoms due to a movable kidney are chronic lumbar pain of the renal type described, which is absolutely relieved only by horizontal rest. These symptoms, if present alone, are nearly always cured by nephropexy.

4. When lumbar pain is associated with neurotic symptoms, nephropexy rarely gives relief.

5. Nephropexy fails to cure cases of dyspepsia which are supposed to be due to the obstruction of the duodenum by a movable kidney.

6. The indications for nephropexy in a case of movable kidney are as follows:

a. Intermittent hydronephrosis; (*b*) pain of the character described above; (*c*) possibly in a few cases of Glenard's disease."

Alglave ("Rev. de Chir.," Dec., 1904) describes a number of cases in which ptosis of the kidney led to a descent of the upper part of the ascending

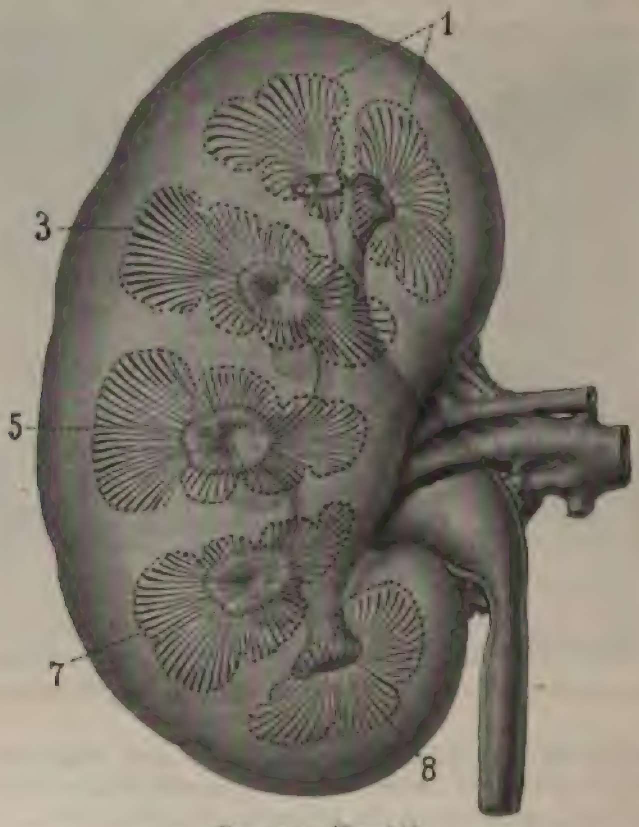

Fig. 734.—(*Broedel.*)

colon, the cæcum remaining fixed. The result of this is an abnormal flexing of the gut, with dilatation and most obstinate constipation. Colitis and pericolitis are commonly present, with many adhesions. According to Alglave, these accidents are secondary to the nephroptosis, but are often so thoroughly established that nephropexy is insufficient to correct them. The author has met this condition in a number of cases and has seen fair results follow liberation of the gut from its adhesions. In bad cases exclusion of the ascending colon by uniting the ileum to the descending colon (see "Intestinal Exclusion") will be found serviceable.

Many surgeons, when operating on the right side, before proceeding to treat the kidney itself in the operation of nephrorrhaphy, open the peritoneum freely, find the ascending colon, draw it out of the wound, and follow one of its longitudinal bands to the appendix. Excise the appendix whether diseased or not. In the hands of an expert this additional step consumes only a very few minutes, and as one eminent surgeon remarked to the writer, "If any operator ever gets close to my appendix, I would never forgive him should he not remove it." The same surgeons who advocate appendicectomy as a step in the operation also advocate exploration of the biliary passages as a routine measure. The inexperienced operator is advised not to add the above-mentioned steps to the operation of nephropexy, as in his hands the extra risk incurred will probably more than balance the benefits which may accrue.

To understand the advantages and disadvantages of the various methods of exploring the kidney and of removing calculi from it, a thorough knowledge

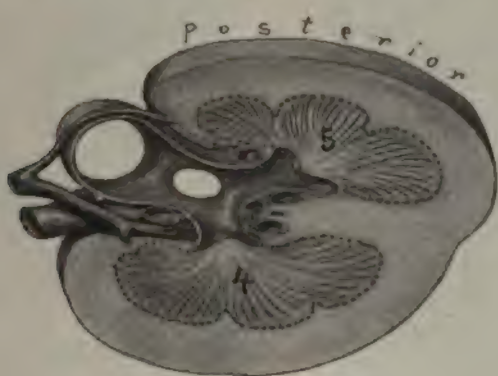

FIG. 735.—(*Broedel.*)

of its surgical anatomy is essential. The descriptions given in many of the text-books of anatomy are entirely insufficient for practical use at the operating table. Of course when a kidney is the site of a large collection of fluid, whether purulent or not, it can be incised and drained or excised without necessitating any exact anatomical knowledge on the part of the surgeon. The same is true when very large calculi are present. In such cases after exposure of the kidney no real exploration is required; the indications for treatment are fairly evident. When it is necessary really to explore the kidney and its pelvis, precise anatomical knowledge is essential.

The kidney may be taken to be composed of a number of conical masses of parenchyma, the secreting tubules of which open on the nipple-like apices of the cones. These cones of parenchyma are fused together into one mass in such fashion that the apices of the cones present into a cavity (sinus of the kidney) completely surrounded by parenchyma except at the inner or concave border of the organ where the sinus or cavity is open (hilum). (Figs. 734 and 735.) The ureter is a tube which runs from the bladder up to the kidney. When the

ureter comes near the hilum of the kidney it expands to form a cavity of varying size, the pelvis of the kidney. The pelvis of the kidney extends into the sinus of the kidney and may be of several types.

(**A**) A number of short tubes may be given off from the pelvis, and into the open expanded end of each of these tubes (calyx) the apex of a renal cone is inserted like an acorn in its cup, so that the urine escaping from the renal tubules flows into the pelvis and so into the ureter. This is the so-called classical or *ampullary type* (Fig. 736) and occurs in about 30 per cent. of cases observed by Delbet and Mocquot. ("Rev. de Gyn. et de Chir. Abdominale," xi, No. 4, 1907.) The tubes leading from the calices to the pelvis are very short, sometimes so short that the apex of the cone may protrude into the pelvis itself.

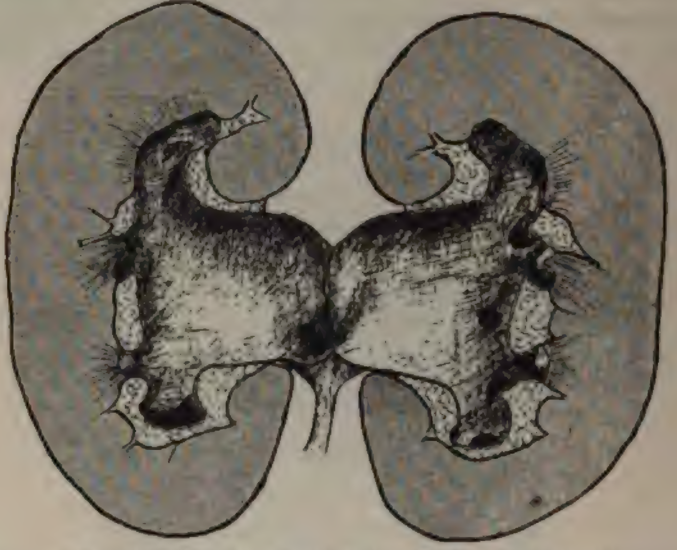

FIG. 736.—Ampullary type pelvis. (*Delbet and Mocquot.*)

(**B**) *Ramifying Type of Pelvis.*—Just inside the opening of the sinus of the kidney the pelvis may divide into tubes (primary tubes); these in turn may give off secondary tubes the open ends of which form the calices. The division of the pelvis may be (*a*) Bifid—one primary tube going to the upper pole of the kidney, the other to the lower pole. (*b*) Trifid—where the third tube goes horizontally to collect urine from the middle portion of the kidney.

A glance at Figs. 736, 737, 738 will explain the foregoing remarks. The pelvis of the kidney and its tributary tubes are attached to the inside of the sinus of the kidney merely by loose connective tissue and fat. There are no openings in the pelvis or its tributaries except the calices and these are plugged by the nipple-like apices of the renal cones. Thus the collecting apparatus (pelvis, tubes, calices) is entirely distinct from the secreting apparatus (the kidney) although it is usually almost entirely hidden within the kidney sinus. The notion is important as it shows that no exploration of the pelvis is possible by

nephrotomy without incision of the pelvis, *i.e.*, without pyelotomy. The renal artery reaches the hilum of the kidney at a higher level than the pelvis and here divides into three or four branches (Fig. 739), one of which passes over the upper border of the pelvis and passes downwards on the posterior surface of the origin of the primary tubes (Fig. 740). This branch usually lies well inside the sinus, but it may be situated along the opening of the sinus (the hilum).

The renal artery or its branches as soon as they enter the hilum lie in contact with the kidney parenchyma to which they give off branches. They are sepa-

FIG. 737.—Trifid pelvis. (*Delbet and Mocquot.*)

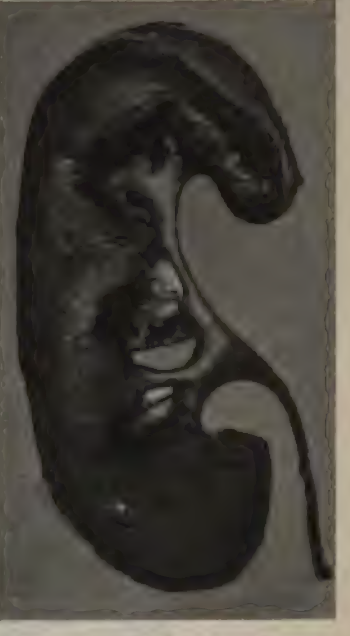

FIG. 738.—Bifid pelvis. (*Delbet and Mocquot.*)

rated from the pelvis and its collecting tubes by loose fatty connective tissue and in the living body, where the tissues are much more supple than in the cadaver, they, *plus* the renal cortex bordering the sinus, can be readily retracted from the pelvis and from part of the tubes (Delbet and Mocquot).

The arteries in their distribution do *not* loop themselves round the calices. One must remember that one or more branches of the renal artery may enter the kidney through its cortical substance, away from the hilum and require separate attention during nephrectomy.

The renal vein and its branches lie between the artery and the collecting apparatus (pelvis, tubes, calices). They are as loosely connected with the latter structures as are the arteries, except that venous anastomoses occur

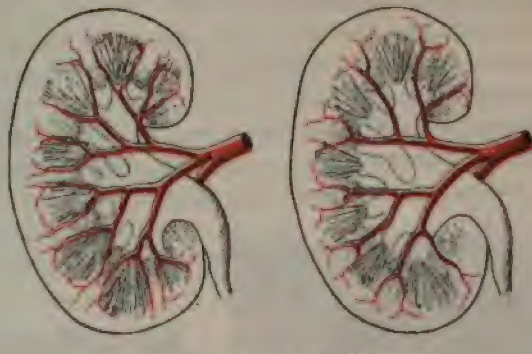

FIG. 739.—(*Poirier and Charpey.*)

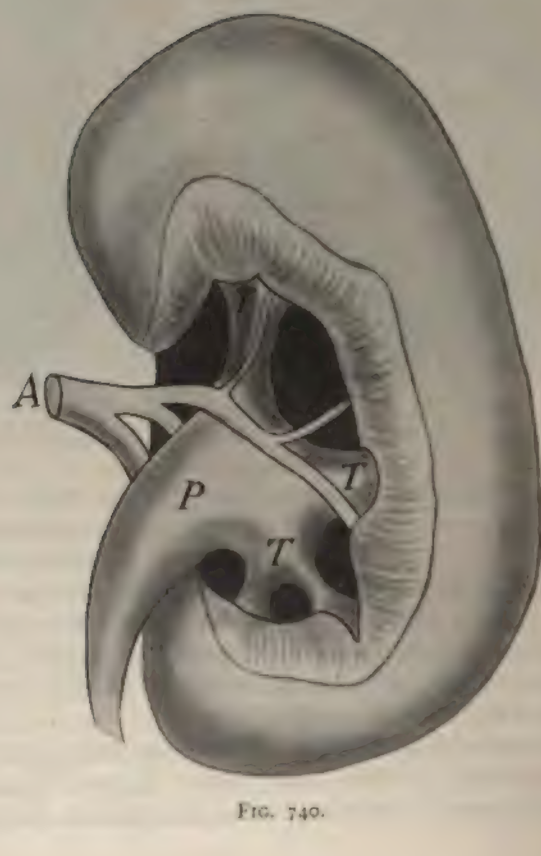

FIG. 740.

around the calices (Figs. 741 and 742). In the fatty tissue of the renal sinus lie the lymphatics and nerves of the kidney.

From the preceding paragraphs it might seem that the sinus of the kidney was always the same shape and bore the same relationship to the pelvis. This would be far from the truth.

Fig. 743 shows a kidney in which there is little notching of the inner border of the kidney and in which most of the renal pelvis lies in an accessible position,

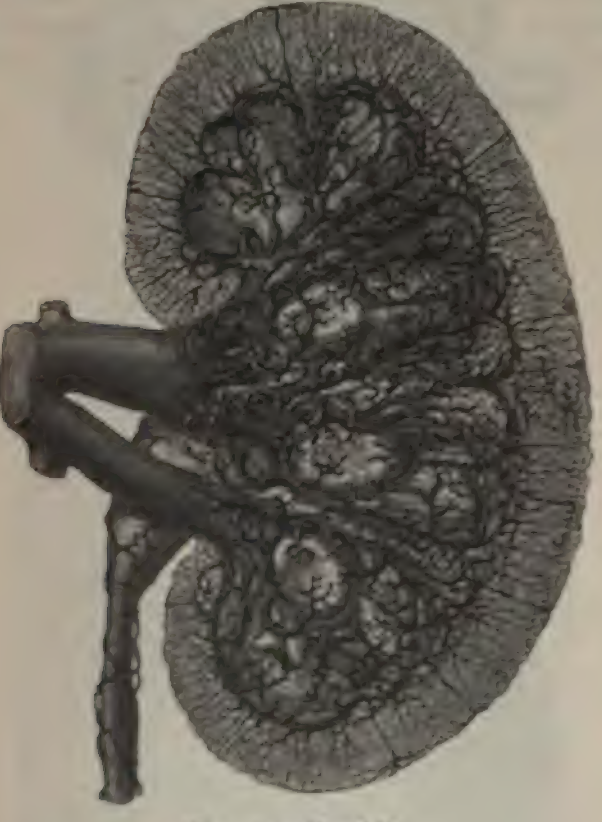

FIG. 741.—(*Broedel.*)

i.e., not inside the sinus. Fig. 744 shows a very different arrangement in which the sinus opens at the bottom of a deep, acute-angled notch. The pelvis is small and is almost completely contained within the notch and the sinus. Between these two varieties there are all sorts of gradations.

Exploration of the Kidney.—Expose the kidney, preferably by Methods A or G, only with the patient in the prone position. By pulling upon the fatty capsule and by pressing on the abdomen with the hand, bring the kidney into the wound and deliver it on to the back, where it may be palpated and inspected thoroughly. Should it be impossible to safely deliver the organ (because of adhesions, etc.) separate it by blunt dissection from its surroundings, except, of course, at the

hilus, when its whole surface and pelvis may be palpated. Should the presence of calculi be suspected, but not be determined by palpation, it is often advised to perforate the organ in all directions with a fine round needle (lady's hat-pin).

FIG. 742.—(*Broedel.*)

FIG. 743.—(*Delbet and Mocquot.*)

Whenever the needle touches a calculus, a sensation of grating is communicated to the hand. Should a cyst of the kidney be discovered, its contents may be obtained for examination by means of the exploring needle and syringe.

The above exploration of the kidney often fails to give the information desired, and further investigation is necessary.

Exploration of the Renal Pelvis without Pyelotomy. Delbet's Method.—Expose the kidney through the lumbar route, deliver it on to the back and place it so that its posterior surface is exposed to view and touch. Beginning at its ureteral end, free the posterior surface of the renal pelvis from its covering of loose fatty areolar tissue by blunt dissection. Push aside the areolar tissue and retract it, very gently, along with the blood-vessels and the parenchyma forming the wall of the sinus. The same dissection may be made, if necessary, on the anterior surface of the pelvis. By this means most of the pelvis, often all of it,

FIG. 744.—(*Delbet and Mocquot.*)

and sometimes the beginning of the primary tubes may be exposed to view. It is now possible to pass the finger into the sinus behind the pelvis without tearing anything and thus directly palpate the pelvis. The finger can be introduced in the middle transverse diameter of the kidney to the bottom of the sinus and can palpate the middle calices; towards the upper and lower poles it cannot be introduced so far, but it can always explore a considerable portion of the upper and lower primary tubes.

Delbet's method permits useful accurate palpation without danger; the ordinary methods of palpation unaccompanied by the dissection described are clumsy and only calculated to reveal gross lesions.

Nephrotomy.—*Step* 1.—Expose and isolate the kidney as in the operation of exploration.

Step 2.—Deliver the kidney on to the patient's back. Surround the hilus or pedicle with a rather fine rubber band or tube not too tightly applied, and fastened by tape and forceps, as shown in Fig. 745. This renders the next step practically bloodless, but entirely prevents exploration of the ureters. An intestinal clamp with rubber covered blades serves the same purpose. Instead of using the rubber constrictor, an assistant may control the circulation with finger pressure applied to the hilus, or no control of the circulation may be attempted. In some cases it is impossible to deliver the kidney safely. Under these circumstances hook the finger in front of the organ and bring its convex margin as well as possible into the wound.

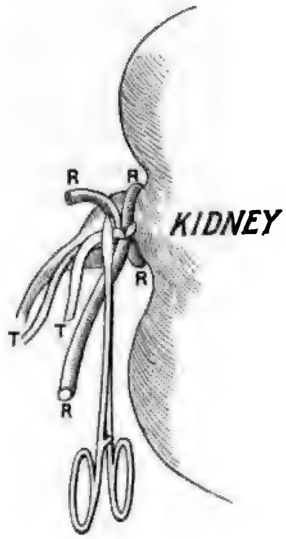

FIG. 745.
R. Rubber tube or band. T. Tape placed over the crossing-point of rubber tube, and held by forceps. It is just as good to fix the rubber by the forceps without the use of the tape.

Step 3.—Grasp the kidney between the fingers and thumb of the left hand and make a longitudinal cut along its convex border of such size and depth that the finger may be passed into the renal pelvis. If necessary, the kidney may be split open throughout its whole length, as is done at the postmortem table (Fig. 546). Introduce the finger through the wound and palpate the interior of the kidney and its pelvis; the fingers of the other hand applied to the surface of the organ aid this exploration. If the elastic constrictor has not been employed or after its removal, the ureters may be examined by ureteral catheters or bougies passed through the wound. To obviate this trouble it is proper to apply the constrictor to the vessels alone. When the active examination or operation is

FIG. 746.—(*Monod and Vanverts.*)

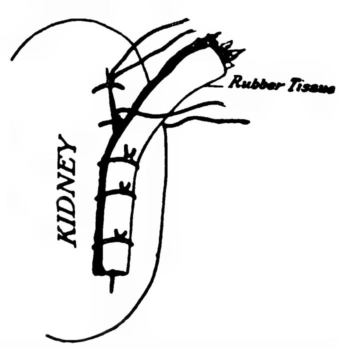

FIG. 747.—Suture of kidney. Stitches tied over rubber tissue drain.

completed, close the renal wound with a few catgut sutures introduced by a round needle, *i.e.*, one without cutting edges. The sutures stop all hemorrhage. Close the lumbar wound, in layers, with buried sutures or with

through-and-through sutures of silkworm-gut. Provide for drainage if necessary. This may be accomplished by placing a few layers of folded rubber tissue over the line of suture, and tying the ends of the catgut sutures, left long for this purpose, over the tissue (Fig. 747).

The above is the classical method of performing nephrotomy, but it takes no cognizance of the arrangements of vessels inside the kidney and hence may destroy an unnecessary number of important vessels, thus cutting off nutriment from and causing necrosis of an unnecessary amount of cortex.

FIG. 748.—Broedel's line for incising kidney. (*Broedel.*)

The arteries are distributed to the cortex in two groups—an anterior and a posterior group. The anterior vascular region is wider than the posterior. According to Broedel, the line bb[1] (Figs. 748 and 749) overlies the principal vessels of the kidney parenchyma and in lobulated kidneys is marked by a distinct depression on the surface, over which the capsule seems thickened, forming a whitish band to which the perirenal fat may be more adherent than elsewhere. An incision (cc[1]), just posterior to the lateral convex border of the kidney (aa[1]) gives good access to the posterior group of calices and injures the fewest possible vessels.

Cullen and Derge split the kidney by passing a long, blunt, flat needle through it from pole to pole and by means of this needle introduce a fine silver wire of low tensile strength. A see-saw motion given to the wire permits it to cut its way out of the kidney without causing bleeding. The method is identical with that used by potters to cut clay. In kidneys where disease has caused the formation of areas of fibrous tissue so much pressure must be put on the wire that the resulting trauma occasions more bleeding than would be caused by the use of the knife (E. H. Richardson).

Marwedel's Nephrotomy.—Expose the kidney by the lumbar route. Deliver it on to the back. At the middle of the convex border of the kidney make a *transverse* incision through the parenchyma into the pelvis. Introduce the finger to explore. If more room is required enlarge the incision both anteriorly and posteriorly until the kidney is divided into an upper and lower half. It is now easy to so open the wound that the pelvis becomes very accessible. Marwedel claims his operation (*a*) unusually free access to the renal pelvis; (*b*) less

destruction of parenchyma; (*c*) less injury to important blood-vessels and consequently less necrosis of parenchyma. Zondek shows that injury to blood-vessels is quite as great as in the longitudinal incision When the renal pelvis is of the ampullary type (30 per cent.) undoubtedly Marwedel's method will give perfect access to it, but when the pelvis is of the ramifying variety the state of affairs is very different and the exposure may be practically *nil*.

When nephrotomy is performed as a therapeutic measure, complete closure of the renal and lumbar wounds is almost always improper. Drainage must be provided. Drainage may be accomplished as follows:

(*a*) Introduce a wick of mildly iodoformized gauze, surrounded by rubber tissue (cigarette drain), into the portion of kidney to be drained and fix it there

FIG. 749.—Broedel's incision of kidney. (*Broedel.*)

by a stitch of plain catgut or tie the ends of one of the renal sutures around the drain (Fig. 750). This simple precaution is perfectly harmless and prevents displacement of the drain. A drain of folded rubber tissue or oil-silk without any gauze is probably better than the cigarette as gauze adheres to the tissues and may favor the formation of fistula. It is wise to leave the drain *in situ* for a week or longer.

(*b*) Use in the same manner a rubber tube split longitudinally and containing a wick of gauze. The split runs the whole length of the tube, diminishing its rigidity and thus avoiding some possibilities of injury to tissues from pressure. Do not insert the tube too deeply, as it may then cause much pain, and even reflex anuria.

(*c*) In the same manner use and fix in place a dressed rubber tube (Fig. 751).

F. Voelcker (Zent. f. Chir., 13, June, 1914) in a case of secondary hemorrhage a few days after nephrotomy, delivered the kidney on to the back, applied compressive dressings and in four days later returned the kidney to its bed. This procedure was successful and ought to take the place of nephrectomy under similar circumstances.

If the kidney is the seat of multiple abscess and nephrectomy is not indicated, open all the abscesses freely, either through the original renal incision or through individual incisions, as may be convenient. If it is believed that relief of tension

may be of value in a case where nephrotomy has revealed no pathological condition sufficient to account for the symptoms, then it is wise to leave the renal wound at least partly open. A. H. Ferguson, Edebohls, and others practise decortication of the kidney when they desire to relieve tension in cases of nephritis. Their operation for nephritis consists in exposure, delivery, and decortication of the kidney. Excellent reports have been published as to the success of decortication in nephritis, but the whole question is still *sub judice*. Wounds of the kidney heal rapidly when sutured.

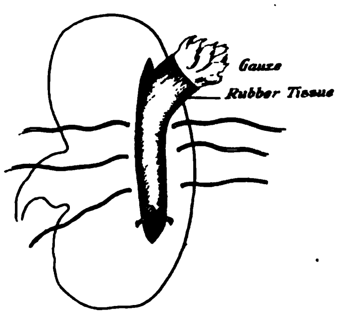

FIG. 750.—Drainage of kidney.

F. S. Watson ("Annals of Surg.," Dec., 1905; March, 1906; Sept., 1907) recommends double nephrostomy to take the place of ureteral implantations: (1) as a palliative measure in cases of inoperable vesical tumor or of vesical tuberculosis causing suffering where the infection is descending and both kidneys are involved; (2) as a preliminary to total extirpation of the bladder. After the kidney is exposed and incised, the ureter is ligated as near the renal pelvis as possible. When the urinary fistula is established, place *over* (not into) it a cup-shaped shield or funnel connected with a metallic receptacle. The receptacle can be conveniently emptied even in a public urinal by means of a rubber tube (Fig. 752).

Rovsing instead of nephrotomy practises lumbar ureterostomy as a part of complete cystectomy (see cystectomy). Wilms (of Basel) exposes the ureter at the brim of the pelvis, preferably extraperitoneally,* and brings it out of the wound about 2 inches above the anterior superior spine of the ilium. If the ureteral stump is long enough it is well to pass it through a subcutaneous tunnel for a distance of 1½ to 2 inches. After the wound has healed it is easy to cut the skin, under which the ureter runs, in the form of a flap and so to envelop the ureter in the flap of skin as to form a convenient spout (Fig. 753).

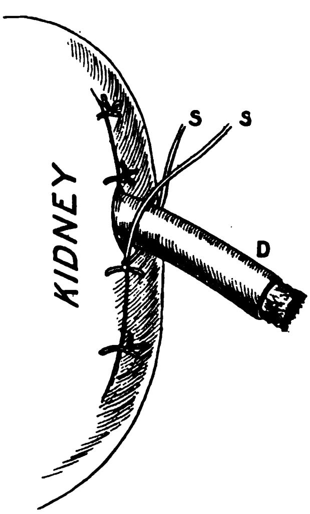

FIG. 751.—Drainage of kidney.

Nephrolithotomy.—Expose and if possible deliver the kidney as in nephrotomy. Control the renal circulation by finger pressure at the hilus or by the elastic constrictor, if this is feasible. Incise the kidney as in nephrotomy. If the stone is small and lies free in the pelvis, pass a forceps through the renal wound and extract it. When the stone is large and fills the renal calices, its extraction becomes a matter of great difficulty. Under such circumstances enlarge the incision through the

* For exposure of ureter see Ureterotomy.

kidney to the necessary extent. With the finger, peel the stone out of the calices and remove it unbroken. If its removal entire is impossible fracture it with forceps, but let the fragments be as few in number as possible. If there are many and small fragments, some of them are liable to escape extraction and cause trouble in the future. Remove all débris, with finger, spoon, forceps, gauze strips, or douche. When several calculi are present, they may often be extracted through the same renal wound, but if more convenient, they may

FIG. 752.—Watson's nephrostomy. (*Watson, Annals Surg.*)

be removed through separate incisions. It is far less damaging to the kidney to make several clean incisions through its parenchyma and thus extract the calculi with the minimum of laceration and contusion than to endeavor to take them all out through one cut. The latter plan too often results in the kidney's being converted into ragged mass lying inside a nearly perfect capsule.

The calculi having been removed, introduce and fix drains in the renal wounds, as has been described under the heading Nephrotomy. Close the

nephrotomy wounds as far as necessary with catgut. Close the lumbar wound except where the drains emerge. A stone weighing four and one-half ounces has been removed in the above manner.

Pyelotomy and Pyelolithotomy.—The kidney is exposed and if possible delivered after the methods already described. The pelvis of the kidney is incised. The incision should not be located too near the renal parenchyma, for the following reasons (Israel): (1) In this location sutures are inserted with difficulty and are liable not to hold. (2) When a stone is being extracted through such a cut, the renal parenchyma may be injured, resulting in hemorrhage and subsequently renal colic from the blood-clots formed in the pelvis and ureter. After the stone is extracted, the pelvic wound is to be closed by a few catgut sutures unless drainage of the pelvis is demanded. Wounds of the pelvis of the kidney heal readily when infection is absent. The Mayos find that closure without leakage may be secured even if the suture of the pelvis is very imperfect provided the pelvic wound is covered by a flap of fatty fascia. In nephrolithiasis there is often a distinct increase in the amount of fatty tissue attached to the pelvis. If it is possible to make the pelvic incision through this fat do so, and after suturing the pelvic wound, close the fatty wound separately with fine catgut. If the pelvic wound is too large or irregular, or if the fat does not naturally cover it, it is easy to make a flap of fatty tissue from the neighborhood, lay this flap over the wound and keep it in position by a few fine catgut stitches. The lumbar wound should be drained by means of folded rubber tissue or oil-silk.

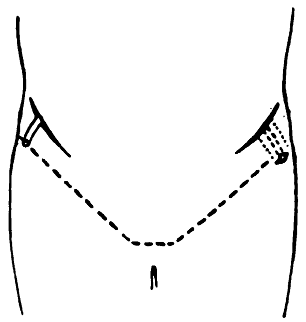

FIG. 753.—Wilm's ureterostomy.

Delbet's Pyelotomy.—"This may be necessary to permit complete exploration of the superior and inferior calices, to extract a calculus or to remove false membranes which are sometimes present in cases of pseudo-membranous pyelitis." Make an incision through the middle of the posterior surface of the pelvis in the long axis of the pelvic funnel. Do not let the incision involve the ureter, as this might cause stricture. In almost every case it is possible to make a cut large enough to admit the little finger and with it to explore all the tubes and calices. A fine scoop may be used to reach parts inaccessible to the finger. If a pelvis is too small to permit of this incision and exploration, it is fairly safe to assume that it is healthy and contains no foreign body. After completing the exploration, close the wound with fine catgut sutures; if silk is used the suturing must be of the Lembert type. Delbet uses two layers of suture; the first, of fine catgut, penetrates the whole thickness of the pelvic wall, the second, of silk, is introduced in the Lembert fashion and does not penetrate into the pelvic cavity. Simple suture with catgut is all that is really necesasry, the supplemented sutures of silk do more harm than good. Payr after suturing the pelvis reflects a flap of the fibrous capsule of the kidney having its pedicle near the hilus, and sutures this flap over the pelvic wound.

Comparative Advantages or Disadvantages of Pyelolithotomy and Nephrolithotomy (Rovsing).—*Pyelolithotomy.—Advantages:* Little hemorrhage and no injury to renal parenchyma. *Disadvantages:* Stones in the calices cannot be removed. Fistulæ are liable to result and persist.

Nephrolithotomy: By means of this procedure all stones can be removed. When no suppuration exists the renal wound may be closed and heal *per primam*. If pus is present, the wound may be partially closed and drainage provided. Fistulæ when they occur are more readily closed than after pyelotomy. In many cases the hemorrhage which may occur is not of importance. Hemorrhage would be dangerous in patients weakened by prolonged disease or in cases where it is necessary to split the kidney throughout its whole length in order to remove a very large stone, were it not that the renal vessels may be readily controlled by the finger pressure or the elastic constrictor. The injury to the parenchyma inevitably incurred is of comparatively little importance.

The above are Rovsing's views, and his opinions always command respect. The experiments of Delbet and Mocquot show that it is much easier to reach every calyx in the search after small calculi by means of pyelotomy than by nephrotomy.

John Clay ("Brit. Med. Journ.," May 1, 1909) recommends the following procedure in cases of double nephro-lithiasis where there is much destruction of renal tissue.

Operation.—Expose the kidney through the loin. Open the peritoneum and palpate the opposite kidney to make sure of its condition. Close the peritoneal wound. Deliver the kidney on to the back. Loosely pack with gauze the cavity from which it was removed. Extract the stones from the pelvis and calices. Attend to hemostasis. Wrap the kidney in gauze and let it lie on the patient's back draining into the dressings instead of into the loose retro-peritoneal tissues.

Operation 2.—As soon as the kidney is covered with healthy granulation tissue, replace it in its normal bed and close the wound after providing for drainage.

After a proper lapse of time the second kidney may be treated in a similar manner.

Partial Nephrectomy.—Experiment and experience show that wounds of the kidney heal readily, and that large parts of the normal kidney may be removed without noticeable ill effect. Tuffier's experiments seem to show that one-third or one-fourth of the kidney is sufficient for the performance of function.

The kidney is exposed and delivered through any of the incisions already described. The diseased portion of the organ is removed, if possible, by a **V**-shaped incision, so that the resulting wound may be easily closed by catgut sutures. This typical removal is often improper, as by it too much healthy parenchyma might have to be sacrificed. For disease involving the upper or lower ends of the kidney a transverse incision may suffice and sacrifice the least possible amount of healthy parenchyma. In the case of irregular multiple, but localized abscesses, where neither the **V** nor the transverse incision may be applicable, the surgeon contents himself with scraping and cutting away all

the diseased tissue. Hemorrhage is prevented after the last two operations partly by judiciously applied sutures and partly by gauze packing. For the packing to be effectual it may be necessary to stitch the kidney to the lumbar wound. The lumbar wound is closed completely or in part, as already described.

Cases Suitable for Partial Nephrectomy.—Benign neoplasms, *e.g.*, echinococcic cysts, pyonephritic disease, etc. Note, however, that hypernephromata often appear distinctly encapsulated and easily removed by partial nephrectomy, and yet they are very malignant in character.

Nephrectomy.—(A) *Lumbar Route.*—The kidney is exposed by one of the incisions described.

1. *Nephrectomy for malignant disease:* A good rule to adopt when operating for malignant disease is to remove too much rather than too little. The same principles which obtain in excision of the breast obtain in nephrectomy for malignant disease.

Step 1.—Expose kidney *freely.*

Step 2.—With finger dissection separate the kidney from its surroundings until it is left attached by its pedicle alone. If the organ has become firmly adherent to its surroundings, it may be easier to separate the kidney from its fibrous capsule (capsule propria) than from the fatty capsule. In such a case the fibrous capsule may be left to be treated at a later stage of the operation.

Step 3.—The pedicle is examined. The vessels and the ureter are recognized. A ligature carrier is passed between the ureter and the vessels and a double ligature of silk or reliable catgut pulled through. One of the ligatures is placed around the vessels and tied tightly at as great a distance from the kidney as possible. This is to permit division of the pedicle far enough away from the ligature to leave a stump of length sufficient to prevent all danger of the ligature slipping. The other ligature is tied around the ureter. A hemostatic forceps is applied to the pedicle between the ligatures and the kidney. The pedicle is divided close to the kidney, leaving the hemostat attached to the stump. The hemostat gives one control of the stump and is left in position until the condition of the stump has been reviewed and it is evident that the ligature controls the vessels and is in no danger of slipping. After this the forceps is removed.

Step 4.—Make a careful and complete excision of the fatty capsule of the kidney. This is as important as excision of the axillary glands in removal of mammary cancer. The excision is made partly by blunt dissection, partly by cutting with scissors. All firm strands of tissue in which vessels may be hidden should be divided between ligatures or forceps. There must be no rough tearing. The location of the inferior vena cava should be borne in mind.

Gregoire thinks that the suprarenal body ought to be removed with the kidney in the presence of renal cancer.

Step 5.—With retractors expose to sight the whole retroperitoneal cavity. Hemorrhage is attended to and any tears which may have been made through the peritoneum are closed by suture.

Step 6.—Dry the cavity. Provide drainage either by means of gauze packing or by tube. Close the lumbar wound. Unless the wound is infected, the drainage may be dispensed with after two days.

If the tumor to be removed is very large, it is often wise to seize the pedicle and any adhesions with forceps and attend to the ligations after the tumor is out of the way.

Occasionally thrombi, malignant in character, are present in the renal vein and even in the inferior vena cava. Such thrombi should be removed even if it is necessary temporarily to clamp the vena cava itself. Israel is authority for this advice.

2. *Nephrectomy for non-malignant disease:* If the kidney is not too adherent (as a result of old inflammation) to its surroundings, the whole organ can be shelled out of its bed by finger dissection. A pedicle needle is passed between the vessels and the ureter as they enter or leave the hilus; a double ligature is pulled through as the needle is withdrawn. One ligature is tied tightly around the vessels as already described. The ligature intended for the ureter is not yet tied. The ureter is grasped by forceps. The pedicle is divided, leaving a sufficiently large stump, and the kidney is removed. The ureter is now examined. If it is clean and safe, the ligature provided for it may be tied and the ureter allowed to drop into the wound. If the ureter is infected and its cavity dilated and full of pus, it must be thoroughly cleansed both by washing and by scraping with a sharp spoon. After being cleaned, the ureter may be ligated and allowed to retract into the wound, or it may be left open and fixed to the lumbar wound by a few sutures. If the disease for which operation is performed is tuberculous and the ureter is involved, it may be followed, through the lumbar wound, down to the brim of the pelvis and excised to that extent. In any event an effort should be made to deprive the distal ureter of its mucous lining and to close the upper opening of the distal segment by inverting it. Mayo treats the ureter by injecting into it about a drachm of liquid carbolic acid. He finds this effective and harmless.

If in non-malignant disease the kidney is so firmly adherent to its surroundings as to make removal by the usual method a matter of great difficulty, then its fibrous capsule may be opened and the kidney proper separated from its capsule and removed, leaving the fibrous capsule *in situ.* The vessels when isolated are caught in a clamp which is left *in situ.* If the organ peels out without the vessels being isolated and clamped, pack the cavity lightly with gauze; as the surrounding scar tissue gives ample support to the packing this is thoroughly effective for purposes of hemostasis. Any diseased material adhering to the capsule is to be scraped away.

The excision of a very large hydronephrotic kidney calls for manœvures not yet considered. Israel says that observance of two rules makes the operation tolerably easy and safe. *First,* as in the case of all benign tumors, be sure to get down to the capsule propria. This is accomplished by cutting the tissues layer by layer, each layer being raised by two forceps before being cut and the cut being made between the forceps. It is surprising how many layers of more

or less firm fibrous tissue are formed from the fatty capsule and must be passed before the capsula propria is reached. Having reached the capsule, clear as large an area of its surface as is possible without evacuating its contents. *Second*, a trocar and cannula are inserted into the tumor to empty it. The cannula is provided with a long rubber tube to drain away the fluid without soiling the wound. When the tumor has collapsed, withdraw the cannula, at the *same moment* closing its puncture wound by catching up a fold of the tumor-wall (at the point of puncture) between the finger and thumb. Forceps may be used instead of the digital grasp. Pull the now flaccid tumor-wall out of the lumbar wound, separating adhesions with the flat of the fingers of the other hand as the tumor is being delivered. Tough adhesions must be divided between ligatures or forceps. These will be most common near the top of the tumor. Do not bore in or mine with the fingers around the tumor, and never endeavor to hook out the growth with the fingers. Such endeavors may tear the pedicle or even lacerate the vena cava. Everything must be done under control of the eye. When the sac is so far extracted that the region of the hilus is reached, even more care must be exercised in the separation of adhesions, as in hydronephrosis the veins are not always gathered together in a convenient pedicle, but are spread out and have many diverging branches. Operating in the above manner, every vessel may be seen and ligated.

(B) *Nephrectomy by the Abdominal Route.*—The kidney is exposed by Langenbuch's incision (page 628). The finger passed through the wound in the mesocolon separates the kidney from its surroundings until the hilus is reached. With an aneurysm needle a double ligature is passed between the ureter and the vessels, and *the vessels* are tied in two places and divided between the ligatures. This double ligation is practised to prevent a flow of blood from the kidney which would obscure the wound. The ureter is divided between forceps. The kidney is removed. The ureter is examined, and if found clean and healthy, it is ligated and allowed to retract into the wound. The whole retroperitoneal cavity created by the removal of the tumor is examined and any bleeding point which may have been overlooked receives attention. Oozing of blood is lessened by temporary pressure with gauze pads wrung out of hot water. Drainage may be provided through the lumbar region in the following manner: From the cavity to be drained a closed forceps is thrust backwards through the lumbar tissues, just external to the quadratus lumborum muscle, until it raises the skin on the back. The skin is incised and the point of the forceps thrust through the incision. If necessary, the opening may be enlarged. Either gauze or tubular drains may be employed, according to circumstances. The above operation appears easy *on paper*, but when the kidney is much enlarged and when it is adherent to its surroundings, the procedure is one of great difficulty. While the organ is being separated from its surroundings it may be necessary to apply many ligatures to control hemorrhage. A large cystic kidney may require to have its fluid contents aspirated before the pedicle can be treated or the tumor delivered. Of course, under such circumstances the puncture wound made by the aspirator or cannula must be closed with forceps as soon as the instrument is withdrawn.

Treatment of the pedicle often presents difficulties. It may be easier to apply clamps to the vascular pedicle than ligatures. If this is done, much care must be exercised. Thornton once included a small piece of the vena cava in the forceps and lost his patient from hemorrhage. Hartmann, while enucleating a large pyonephrotic kidney, tore a hole of 3 cm. (1¼ inches) in the vena cava, below the renal vein. He immediately ligated the vena cava above and below; the patient recovered. Had the tear involved the region of the renal veins, he would have sutured the wound in the vena cava. Damar Harrison has done this successfully. When clamps are used, ligatures must be substituted for them as soon as the tumor is removed. Some surgeons, when possible, ligate the renal vessels before enucleating the kidney. When the ureter is septic, it must be doubly tied near the kidney and divided between the ligatures. The ligation prevents its septic contents escaping into the wound. The ureter (after the kidney is removed) is pulled outwards and fixed in the lumbar drainage wound. Lumbar drainage having been provided, the abdominal wound can be completely closed. Many surgeons advocate careful suture of the wound made through the outer later of the mesocolon so as to close the peritoneal cavity. This is generally considered unessential.

Remarks.—Exploration is indicated in cases where it is believed that the kidney has been ruptured and that extravasation of urine or blood is taking place. Any lacerations found must be closed by suture. If mere suturing is insufficient to stop the hemorrhage, or if the trauma has destroyed much renal parenchyma, the wound in the kidney should be packed with gauze held in place by plain catgut sutures (Fig. 685). The gauze should be surrounded by rubber tissue so as to avoid adhesion between it and the kidney tissues.

The happy results of non-intervention in cases of uncomplicated subcutaneous rupture of the kidney, reported by Alfred Frank from Körte's clinic ("Archiv für klin. Chir.," lxxxiii, 554), are such as to dampen operative enthusiasm. Körte never operates on uncomplicated cases of rupture of the kidney, no matter the extent of hemorrhage and hematoma. If infection is present operation must not be delayed.

Ransohoff promulgates the following theses regarding renal tuberculosis where operation in indicated: "(1) When the operation reveals a strictly localized lesion, a partial excision or curettage should be done.* (2) Nephrotomy is indicated when uncertainty exists as to the condition of the opposite kidney or for the temporary relief of an acute sepsis, and when the condition of the patient will not permit the major operation. It is then to be followed as speedily as possible by nephrectomy. (3) Unless unusual conditions call for nephrotomy, it is not to be advocated for renal tuberculosis. It may even do harm by autoinfection. (4) Primary nephrectomy should be considered the normal procedure for renal tuberculosis when an operation is at all indicated."

Liechtenstern ("German Urological Society," 1907) examined at intervals

* The author has mistaken an apparently well-encapsulated hypernephroma for a localized tuberculous lesion, performed partial excision, and obtained a disastrous result. This error is easily made, and should be remembered.

·ine of seventeen patients submitted to nephrectomy for tuberculosis. camination was by inoculation of guinea-pigs. In seven the results were ve. In three the results were at first positive, later negative. In seven examination showed bacilli. Voelker reviewed the late results of seventeen of operation for renal tuberculosis in the Heidelberg clinic (1902 to 1906). nclusions were (*a*) the disease is less grave in the female; (*b*) in the patients survive the operation the symptoms are late in disappearing (up to two ; (*c*) the mortality during the first six months after operation is 25 per cent. ie presence of a renal calculus always calls for operation. The danger of ndition and especially of the operation is not so much due directly to the as to infection. This seems a truism, but in renal and biliary surgery cians and patients are far too prone to delay interference until such becomes ictly, if not very, dangerous. The same reasons which make early operaafe in cases of appendicitis call for early operation in renal calculus, although latter a moderate amount of delay does not lead to such disastrous results. yonephrosis or surgical kidney demands operation. If the disease is so e that drainage will put too great strain on the patient's recuperative rs; if the other kidney is in such health that it can be depended upon for nation, and if the immediate condition of the patient permits nephrectomy, nephrectomy is the operation of choice. When doubt exists as to the funcl ability of the other kidney, or when the general condition of the patient raindicates the more severe operation, drainage is the operation of choice. same is true in calculus disease when infection is present. If in the above ise the inflammatory process is moderate and a useful amount of renal paryma remains intact, drainage gives excellent results, or partial nephrectomy drainage may be the better procedure to adopt.

Anuria, especially calculus anuria, calls for nephrotomy, and, as Morris its out, the operation ought to be on the kidney which appears to have bee last affected, *i.e.*, on the organ which presumably is in the better condition. iria following nephrectomy calls for immediate nephrotomy on the remaining ney. (Willy Meyer.)

Harrison demonstrated long ago that operations undertaken for calculi ved in many instances curative, even when no calculi were found, and he cluded that nephrotomy might be a reliable therapeutic agent in certain es of acute nephritis by relieving renal tension. A. H. Ferguson, Edebohls, l others believe that by decortication of the kidney a cure (symptomatic at it) may be obtained in chronic interstitial nephritis. At present this sub is distinctly *sub judice*, but very remarkable results have been claimed by oughly reliable men.

E. Martini ("Archiv für klin. Chir.," lxxviii, p. 619) experimented on dogs. arious periods after kidney decortication (even after many months) he killed nimals by bleeding; ligated the renal artery and vein and then injected gelatin through the aorta and ascending vena cava. By these means was able to study the collateral circulation of the kidney. An abstract clusions follows:

1. The new renal capsule is principally the result of growth of the interstitial connective tissue and of the endothelium of the vessels of the cortical zone of the cortex.

2. New capsule is firmly adherent to the kidney, is not of uniform thickness, but is thicker than the normal capsule. Its thickness is greater if the fatty capsule has been removed and nephropexy performed as well as decortication.

3. The new capsule shows no tendency to shrink or to sclerosis; it retains its normal structure and rich vascularity.

4. Decapsulation causes only temporary phenomena of hyperemia in the periphery of the kidney and no epithelial degeneration.

5. There is a temporary decrease in the secretion of urine from simple causes.

6. Ligation of the renal artery or vein causes more degeneration and necrosis in normal than in previously decapsulated kidneys.

7. The collateral circulation through the new capsule can fully compensate for the stoppage of outflow through the renal vein when it is ligated; it only partially takes the place of the renal artery when that is ligated.

8. Decapsulation and simultaneous ligation of the corresponding renal vein is fatal.

9. If both kidneys have been decapsulated and are provided with a new formed capsule, one renal vein may be ligated and a month later the other ligated also without death of the animal.

10. A dog can survive simultaneous ligation of the artery and vein of one kidney only when the fibrous capsule of that kidney has been previously extirpated.

11. The collateral circulation of a previously decapsulated kidney is sufficient to preserve the life of a dog when the other kidney is removed and the vein of the decapsulated kidney is ligated.

Congenital Cystic Kidney.—This disease is usually bilateral and is thought to kill because of the pressure exerted by the innumerable cysts upon the secreting tissues. If the growth and multiplication of the cysts could be stopped, then a practical cure might be attained.

Fred Lund (Journ. A. M. A., Sept. 26, 1914) has followed Rovsing in exposing the kidney in the loin, puncturing all the exposed cysts. A large part of the posterior surface of the kidney may be seen and the cysts punctured by proper retraction of the wound. As the cystic contents flow out, the kidney decreases in size and can be delivered and held in the hand. It is now easy to palpate large cysts and collections of cysts and to empty them with a hollow needle. In this manner a kidney which was from six to ten times the normal size may be reduced to twice the normal, returned to its bed and the wound closed without drainage. Both Rovsing and Lund have had a few gratifying results from this operation.

Bevan and McRae have each seen cases of unilateral polycystic kidneys.

Horse-shoe Kidney.—A. Martinow ("Zentralblatt für Chir.," 1910, No. 9) describes a case of horse-shoe kidney in which he operated with good effect. The report is so suggestive that it requires consideration and may aid the

surgeon in locating a very limited class of obscure abdominal trouble. A nurse, aged forty-nine, complained from child-hood of a disagreeable pulsating sensation in the whole abdomen; for many years there was severe pain above the umbilicus and marked obstipation. The pains increased and did not disappear at night. The patient became hysterical, and underwent treatment for hysteria during many years. Appetite poor; occasional vomiting; bowels moved every two or three days; marked peristalsis and abdominal pains. A tumor was palpable above the umbilicus. Aorta, tumor, and cæcum tender on pressure. Tumor occasionally increases in size when the pulsation of the aorta and other abdominal arteries becomes stronger and more annoying. No pain in the kidney regions. All other organs normal.

Diagnosis.—Tumor of pancreas or horse-shoe kidney. Laparotomy was performed. A tumor was found lying directly on the aorta; it was about 4 cm. wide and 2 cm. thick and formed an isthmus uniting the two kidneys lying one on each side of the vertebral column. The diagnosis of horse-shoe kidney was clear. Each half of the abnormal kidney was provided with a ureter.

After incision of the peritoneum overlying the tumor the isthmus was grasped with two intestinal clamps and divided. Immediately the two halves of the kidney retracted one from the other and the aorta was freed from pressure. After removal of the clamps from the kidney hemorrhage was easily controlled by a few catgut sutures. The peritoneal wound was sutured and the abdomen closed without drainage. Martinow writes, "I would not assert that the isthmus should be divided in cases where horse-shoe kidney is discovered accidentally during an operation, but I do intimate that in cases with symptoms due to pressure on the sympathetic plexus this simple operation is possible and ought to be tried."

CHAPTER XLVIII

OPERATIONS ON THE URETER*

Anatomy.—The ureters conduct the urine from the kidneys to the base of the bladder, the walls of which they pierce obliquely, thus providing themselves with valvular outlets. The average length of the ureter is 12 inches; its narrowest point is about 2½ inches below the hilum of the kidney (diameter here about ⅛ inch), and the next narrowest point is at the brim of the pelvis. Calculi are liable to become caught at these two places and at the point where the bladder is entered. The ureters are lined by a thin mucosa which is thrown into folds. A thick muscular and a thin but elastic external fibrous tunic complete the ureteral wall.

The ureter lies loosely in the post-peritoneal connective tissue. "In the abdominal portion of its extent it lies upon the front of the psoas muscle, and about half-way between its commencement and the brim of the pelvis, or somewhere below that point, it crosses in front of the genito-crural nerve. The upper half of this portion of the duct, except at its commencement on the right side, where it is covered by a third part of the duodenum, is in direct contact with the peritoneum, to which it is intimately connected; and the lower half is separated from the peritoneum by the spermatic or ovarian vessels, which are, however, closely united both to the ureter and to the serous membrane. . . At the brim of the pelvis the relation of the ureter to the large vessels is not always quite the same, as it may rest either upon the lower end of the common iliac artery or upon the external iliac; it is covered in front by the peritoneum and it is crossed on the right side by the termination of the ileum, and on the left by the commencement of the rectum." (Morris, "Surgery of the Kidney and Ureter.")

Tourneur's point corresponds approximately to the upper end of the ureter and the level of origin of the spermatic or ovarian artery. Draw a transverse line from the tip of one twelfth rib to that of the other. Draw a vertical line upwards from the junction of the middle and inner thirds of Poupart's ligament. Where these two lines cross is Tourneur's point.

To find where the ureter crosses the iliac artery, Morris gives the following advice: For practical purposes, a point lying at the junction of the upper and middle thirds of the line indicating the course of the common and external iliac arteries will sufficiently indicate its position. The line marking the course of the iliac vessels is drawn from the bifurcation of the aorta, half an inch below and to the left of the umbilicus, to midway between the anterior superior spine of the ilium and the symphysis pubis.

* In this chapter very free use has been made of Morris' work on "Surgical Diseases of the Ureter and Kidney."

Hydronephrosis is commonly the result of ureteral obstruction, whether due to calculus, stricture, external pressure, or torsion of the tube from renal ptosis. Of course, the cause must be sought and, if possible, removed.

Very frequently a branch from the renal artery, or even direct from the aorta enters the kidney at a point remote from the pelvis. The ureter may become

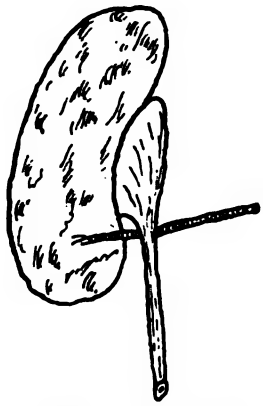

FIG. 754.—(*Eckehorn.*)

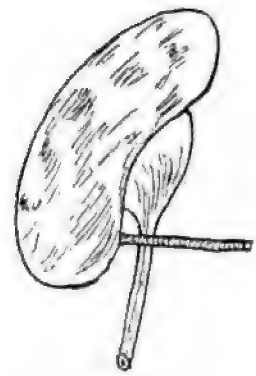

FIG. 755.—(*Eckehorn.*)

kinked over this branch. The above is a common cause of hydronephrosis and ligaton, and division of the aberrant vessel is usually the proper treatment.

A glance at Figs. 754, 755 and 756 shows diagrammatically the relations of the ureter to aberrant vessels, while Figs. 757, 758 and 762 show how the vessels may produce hydronephrosis.

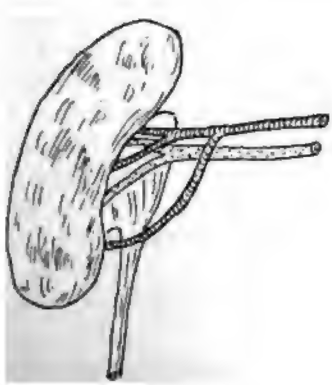

FIG. 756.—(*Eckehorn.*)

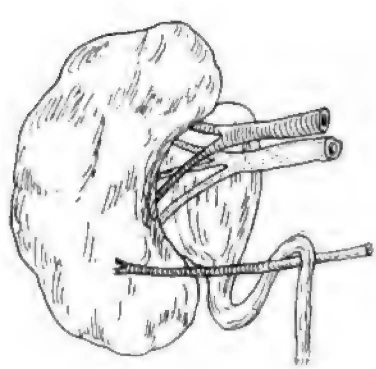

FIG. 757.—(*Bazy.*)

Bland Sutton believes that the kinking of the ureter over the abdominal vessel is the result, not the cause of the hydronephrosis. A number of reliable surgeons, however, find that the hydronephrosis is cured after division of the vessel apparently causing the kinking.

[illegible] to note the relationship between the ureter and the pelvis

[illegible]

of the kidney. Normally the ureter opens into the lowest point in the pelvis, but in hydronephrosis the opening may be high up on the pelvic wall, and hence escape of fluid from the kidney becomes impossible even if the original obstruction of the ureter is remedied. Various operations have been devised for the correction of the faulty relation between ureter and renal pelvis.

Mynter's Method.—Expose and explore the kidney and its pelvis. Make an incision into and explore the interior of the greatly dilated pelvis or the hydronephrotic sac. If possible, pass a catheter through the ureter down to the bladder and find if ureteral stenosis exists. If the opening of the ureter is high up on the side of the sac (Fig. 759), make the incision A, B, through the wall of the sac, parallel and opposite to the ureter. Make the similar

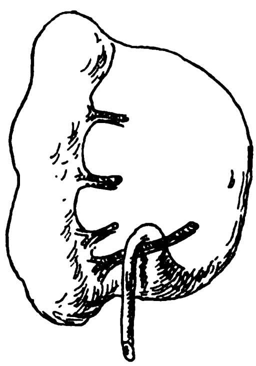

FIG. 758.—(*Bazy.*)

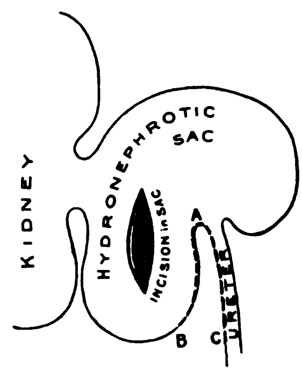

FIG. 759.

incision A, C, in the ureter. Unite the anterior edge of the ureteral wound to the anterior edge of the sac wound (x–x[1], Fig. 760). Unite the posterior edge of the ureteral wound to the corresponding edge of the sac wound (Y–Y[1]). The sutures, of fine silk or hemp, must not include the mucosa in their bite. (This lest calculi form on them). The result is a lowering of the ureteral orifice to the lowest point in the sac. The operation is identical in principle with Mikulicz's pyloroplasty. If a ureteral stricture exists between the points A and C, the operation of courses cures that also. When obstruction is due to kinking of the ureter over one of the renal vessels, either make an anastomosis between the sac and the ureter below the obstruction (Fig. 762, X–Y) or divide the ureter and unite the open end of the lower segment to the lowest point in the hydronephrotic sac.

Mayo's method of using a flap of fat to support the line of suture in the kidney pelvis is most valuable (see p. 649).

Küster ("Archiv f. klin. Chir.," xliv, 850) describes a case where the above operations were impracticable, as an impermeable stricture of the ureter existed a short distance below the sac. He divided the ureter immediately below the stricture, separated it sufficiently from its surroundings so that it could be brought up to the sac without tension, split the upper end of the ureter (Fig. 763), made an incision through the posterior wall of the sac at his lowest level, spread

open the split upper end of the ureter and sutured it to the vivified internal surface of the anterior wall of the sac (Fig. 764). The ureter was thus formed into a sort of funnel opening into the sac. The wound in the sac was closed with sutures (Fig. 765). The result was good. Israel has lessened the size of the distended pelvis by a plication of its walls similar to that practised for the cure of dilatation of the stomach. Occasionally in hydronephrosis a valve is present

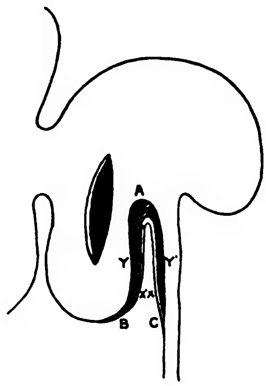

FIG. 760.

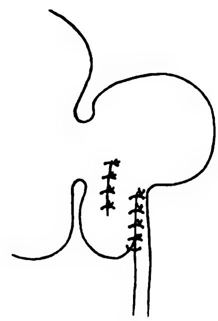

FIG. 761.

FIGS. 760 AND 761.—Mynter's operation.

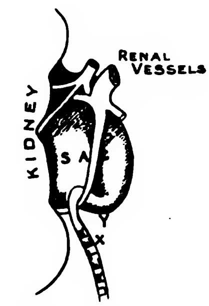

FIG. 762.—(*Modified from Morris.*)

at the ureteropelvic junction, which prevents the complete evacuation of the renal pelvis or hydronephrotic sac. Fenger's operation for this condition is as follows: Expose the kidney. Open the renal pelvis and examine the interior, especially the uretral opening. Pass a bougie into the ureter. Excise the valve by a transverse incision (Fig. 766, A B). Close with fine catgut sutures the wound left by the incision of the valve. Close the wound in the sac.

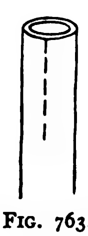

FIG. 763.

FIG. 764.

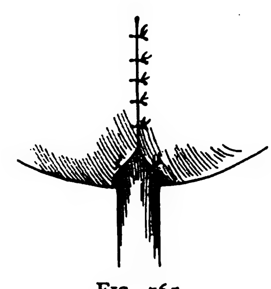

FIG. 765.

FIGS. 763, 764 AND 765.—Küster's operation.

When hydronephrosis is due to or kept up by a stricture at the junction of the ureter and pelvis, the operation practised by Fenger was the following: Make the incision A, a (Fig. 767), through the stricture and continue for a short distance upwards through the sac-wall and downwards through the ureteral wall. With sutures unite the points A, a; B, b; C, c, etc. This practically amounts

to an anastomosis between the ureter and the renal pelvis. To avoid tension it may be necessary to separate the ureter from its surroundings for a short distance.

Exposure of the Ureter.—(A) *Transperitoneal Route.*—The ureter can be reached through a median or lateral abdominal incision. This method is valuable as a means of diagnosis, permitting, as it does, palpation of the opposite kidney, and the recognition of stones impacted in the ureter and of other conditions. When a stone is situated low down in the ureter it may be palpated through an incision through the rectus muscle or through a "gridiron" incision such as used in appendectomy, but placed a little more external than in the latter operation. Guided by a finger in the abdomen, strip the peritoneum from the parietes on the outer side of the wound until the ureter and stone are exposed.

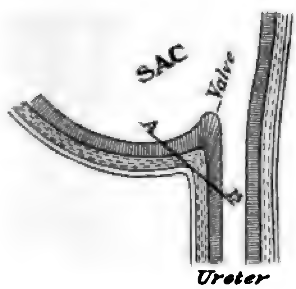

FIG. 766.

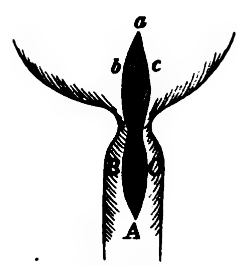

FIG. 767.

FIGS. 766 AND 767.—Fenger's operation.

Protect the wound in the peritoneum either by packing or by closing it. Incise the ureter extraperitoneally. Provide drainage through a separate incision. Morison has frequently operated in this fashion and has never infected the peritoneum. John Gibbon has had similar experience. In operations, such as uretero-ureterostomy and uretero-cystostomy, etc., the transperitoneal route is of great value.

(B) *Extraperitoneal Routes.*—I. *Lumbo-ilio-inguinal route* (Morris): By this route the ureter may be explored throughout its whole length. (*a*) Exploration of lumbar portion of ureter. Place the patient lying on his healthy side with the abdomen turned somewhat towards the table. Do *not* place any pillow under the opposite loin. Beginning at the outer edge of the sacro-lumbar mass of muscles, a little below the twelfth rib, make an incision obliquely forwards and downwards to a point 1 inch internal to the anterior superior spine of the ilium. Continue the incision parallel to and 1 inch above Poupart's ligament, as far as its centre (Figs. 768 and 769). *Cut down to, but not through,* the peritoneum. Expose the kidney. Palpate the renal pelvis between finger and thumb. By exercising slight traction on the pelvis the ureter may be made more prominent. With the fingers or a pledget of gauze strip the peritoneum from the parietes until the ureter is seen. "The relation of the ureter to that part of the peritoneum which is adherent to the spine is rather constant, the ureter being situated just external to the line of adhesion. Therefore, when the operator has

ɔneum and reached this point, he will find the ureter on the ım external to it." (Kelly.) Remember that the ureter ɔneum even when that membrane is raised from the sub- ι little tension exercised on the renal pelvis helps to render ɔle.

ɪf pelvic portion of ureter. Roll the patient over so that his sound side his back, instead of his abdomen, is turned the table. Enlarge the wound, if necessary, forwards, :ternal abdominal ring" (Morris), always carefully avoiding :um. This huge wound may be avoided by seeking the h a low "gridiron" incision which penetrates to, but not

768.

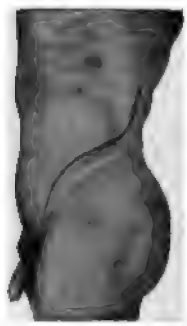

FIG. 769.

ιND 769.—Exposure of ureter. (*Monod and Vanverts.*)

:um. Should the peritoneum be opened by accident, close :s. Sometimes the kidney is not available as a guide to the ed to hunt for that tube at the pelvic brim. Here the guide place where it crosses the iliac artery, and when the peri- off, it will be found adhering to that membrane "like a ·white tape." In the male the ureter may be examined in ɔ the bladder, but in the female it runs in the broad liga- .t very difficult of access. The uterine artery lies in front, ɜ ureter.

.—("Cleveland Med. Journ.," Dec., 1910.)

ı imaginary line from the inner lip of the anterior superior ve the opposite pubic spine. Beginning at a point 1½ to .terior superior spine make an incision along the imaginary ıes (Fig. 770). This terminates at the edge of the rectus "1 the entrance into it of the deep epigastric artery." Split al oblique along the line of the incision. Split the internal rsalis parallel to their fibres and to the nerve trunks which Do not open the peritoneum.

.e fingers dissect the peritoneum up from the side and the A broad retractor placed at the lower end of the incision

gives good access to the deep pelvis. Pass the finger to the bifurcation of the common iliac artery and turn the palm of the finger against the under surface of the peritoneum where it will feel the ureter closely adherent to the peritoneum covered by some of its reflected fibres.

Step 3.—Separate the ureter from the peritoneum for an inch or two, pass a tape around it and apply slight traction when the ureter will stand out like a ridge extending to the base of the bladder.

Step 4.—Remove any stone by incision. Close the cut with plain catgut sutures. *Never* use gauze for drainage. Close the abdominal wound.

FIG. 770.—(*Herrick, Cleveland Med. Jour.*)

Kidd's method (Lancet, June 7, 1913) is very like Herrick's. Trendelenburg's position. Three-inch incision parallel to and $1\frac{1}{2}$ inches above Poupart's ligament. Two inches of the cut extend outwards and one inch extends inwards from the outer edge of the rectus. Split the aponeurosis of the external oblique the whole length of the wound. (N. B. The aponeurosis of the external and internal oblique muscles do not fuse to form the anterior sheath of the rectus until at least one inch inside the edge of that muscle.) Retract the edges of the wound and split the internal oblique and transversalis in the direction of their fibers for a distance of two inches external and one internal to the edge of the rectus. Retract the rectus inwards and observe the deep epigastric vessels as they pierce the transversalis fascia and dip in front of the semilunar

fold of Douglas to enter the rectus sheath. Just external to and above the point where the deep epigastric vessels enter the rectus sheath tear through the transversalis fascia into the subperitoneal fat. Divide the transversalis fascia outwards the whole length of the wound. With the finger separate the peritoneum from the iliac fossa and side of the true pelvis. In the pelvic fossa note and retract downwards and inwards the vas deferens; retract upwards and outwards the spermatic vessels. In the female the ovarian vessels and round ligament are treated similarly. Guided by the external iliac artery find and clear the common and internal iliacs. The ureter crosses the pelvic brim over the external iliac artery and runs down the pelvic wall parallel to and just in front of the internal iliac. It is attached to the peritoneum. Strip the ureter from its bed for a distance of two or three inches above and below where it crosses the external iliac. Long narrow retractors are required to give good exposure.

Introduce into the ureter two sutures of the finest chromic catgut by means of fine needles as shown in Fig. 771. Put strips of gauze under the ureter to soak up escaping urine. Using the sutures as retractors make a very small incision in the ureter with a tenotome. (If the urine is very septic clamp the ureter above the incision with suitable rubber covered forceps.) Introduce a ureteral bougie and locate the stone. Remove the stone with ureteral forceps. Close the ureteral wound with fine catgut sutures and cover this with sutures in the periureteral tissues. There is usually no leakage and the wound heals by first intention. If necessary the ureter may be cleared all the way to the bladder. In the female this involves ligation of the uterine vessels. Introduce a slip of rubber tissue to the site of the ureteral wound as a drain. Close the wound in layers. One particular advantage claimed for the operation is that the ureter is generally opened remote from the site of the stone and hence in a healthier place so that there is less fear of subsequent stricture.

II. *The sacral route:* Morris thus describes Delbet's operation: "(1) The patient should be placed upon his sound side, so that the rectum may fall away from the wound. (2) The incision should be L-shaped, with the long arm vertical, along the border of the coccyx, and the short falling upon the superior extremity of the first, being almost parallel to the fibres of the gluteus maximus. (3) Cut the insertion of this muscle and the sacro-sciatic ligaments and some fibres of the pyriformis. (4) Lay bare the lateral face of the rectum with forceps and a director. The ureter is always to be found adherent to the detached peritoneum, and can be followed downwards to the bladder and upwards for seven or eight cm. from its termination. This description applies specially to man; in woman the operation is more difficult because of the broad ligament."

Various surgeons have used modifications of Kraske's sacral operation to gain access to the ureter, but these have little to recommend them.

(C) *Perineal Route.*—An operation through the perineum, very similar to that used for the exposure of the prostate by a curved transverse incision, permits the exposure of the seminal vesicles, and with them the lower end of the ureter.

(D, E) *Vaginal and Rectal Routes.*—Ureteral calculi palpated through the vagina or rectum have been successfully removed by direct incision through the walls of these cavities. The wounds were sutured immediately.

(F) *Transvesical Route.*—Calculi impacted at the vesical orifice of the ureter may be reached and removed by suprapubic or perineal cystotomy. Young and Bransford Lewis have successfully removed calculi in this position by means of the cystoscope.

Ureterotomy and Uretero-lithotomy.—Expose the ureter by one of the extra-peritoneal methods. Introduce into it, if possible, two catgut sutures (X–X^1, Y–Y^1, Fig. 771), each of which is in the long axis of the ureter. Using the sutures to fix the tubes, make a longitudinal incision into the ureter, over the calculus, if such is present. It is wise, when possible, to push the stone up the ureter, incising at this new point lest ulceration at the site of impaction interfere with

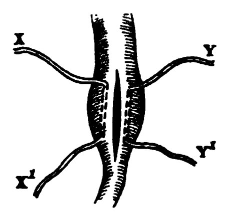

FIG. 771.

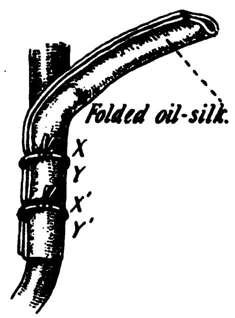

FIG. 772.

FIGS. 771 AND 772.—Ureterotomy.

healing. Remove the calculus or explore the ureter as may be indicated. Apply a long strip of folded rubber tissue or oil-silk over the ureteral wound between the two sutures. Tie the end of the suture X over the rubber tissue to Y, and the end of the suture X^1, similarly to Y^1 (Fig. 772). Bring the free end of the rubber tissue or oil-silk out of the wound in the parietes. Close the parietal wound except where the drain emerges. This closes the ureteral wound efficiently and safely.

Many surgeons suture the wound in the ureter with a few fine silk or hemp stitches which do not involve the mucosa; other surgeons omit all suture of the ureteral wound, trusting to nature to close the wound, draining the wound with rubber tissue or tube. Simple through-and-through sutures of catgut are all that is necessary, but a drain of rubber tissue or oil-silk ought always to be attached to the line of suture. The use of gauze in connection with renal or ureteral wounds is liable to lead to the formation of fistulæ. When drainage of the ureter is desired, one may act as follows:

Trim, in the fish-tail fashion, the end of an appropriate sized rubber tube; wrap around the tube a few layers of gauze; cover the gauze with rubber tissue. Leave about ¼ inch of the "fish-tail" end of the tube free from gauze. Perform the ureterotomy, using catgut sutures as handles (Fig. 772). Introduce

the bared end of the dressed tube into, or over, the ureter. Do not permit the gauze on the tube to be in contact with the ureter. With a needle stitch sutures X-X[1] and Y-Y[1] to the tube; this holds the drain in place.

Ureterotomy for the cure of ureteral stricture is performed as follows (Fenger's operation):

Expose the ureter by the extraperitoneal route. Make a longitudinal incision into the ureter immediately above the stricture; pass a suitable probe or bougie through the stricture; continue the vertical incision through the stricture and downwards until the wound below the site of stricture is equal in length to that above (Fig. 774). With sutures unite the point A to A[1], B to B[1], etc. (Fig. 775). The result is practically the formation of an anastomosis (Fig. 776) between the upper and lower segments of the tube. Close the external wound after providing for drainage.

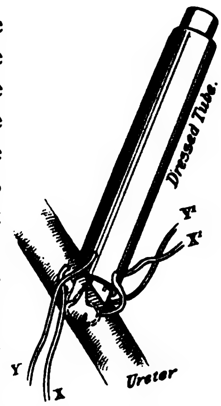

FIG. 773.—Ureteral drainage.

Ureterectomy.—Ureterectomy may be carried out as a step in the operation of nephrectomy or as a secondary operation. The ureter is exposed extraperitoneally by the lumbo-ilio-inguinal incision. It is not always necessary to make the external incision continuous throughout the whole length described on page 662. After the kidney is delivered or removed the ureter may be followed, by a burrowing dissection, down towards the pelvis, a forceps or stout probe passed down to the bottom of the wound to act as a guide, while a second incision is made through the parietes (Fig. 777). No special description of technic is required. Note that an apparently tuberculous ulceration of the vesical mucosa near the mouth of the ureter is not a contra-

FIG. 774.

FIG. 775.

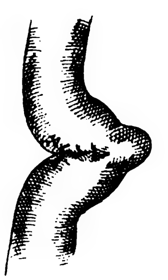

FIG. 776.

FIGS. 774, 775 AND 776.—Fenger's ureteroplasty.

indication to nephrectomy and ureterectomy. When the diseased kidney and ureter are removed, the vesical lesion frequently recovers spontaneously.

Ureteral Anastomosis.—(A) *Monari's Method: Lateral Anastomosis.*—This operation is practically the same as lateral anastomosis of the intestine. Fig. 778 sufficiently explains the method, which is in every way inferior to the Van Hook operation.

(B) *Van Hook's Operation: Lateral Implantation.*—Split the upper segment of ureter for a short distance. This is important, as it prevents stenosis at the orifice (Fig. 779). Ligate the upper end of the lower segment of ureter. Pass the fine catgut suture X Y through the lower wall of the upper segment opposite the split described above (Fig. 779). Make a vertical incision into the lower segment immediately below the site of ligation. With round needles (either

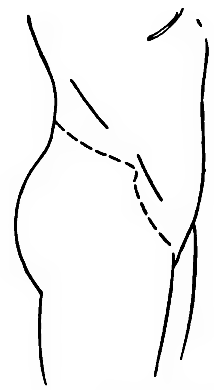

FIG. 777.—Exposure of ureter.

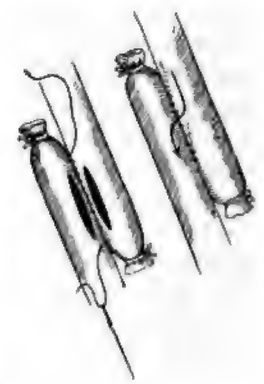

FIG. 778.—Monari's ureteral anastomosis.

straight or curved) pass the suture X Y through the opening in the ureter and make its ends emerge at the points O. N. (Fig. 780). As catgut is not easily threaded in fine needles, one may arm the needles with a suture carrier of silk or hemp, by which means the introduction of the catgut becomes easy (Fig. 781). Insert the lower end of the upper segment of ureter through the wound in the lower segment, pull the suture X Y sufficiently tight, and tie it (Fig. 782).

FIG. 779.—Van Hook's operation.

Whenever possible, the extraperitoneal route should be chosen in performing uretero-ureterostomy.

Uretero-cystostomy.—This operation is called for in certain cases of persistent ureteral fistula, in cases where part of the ureter has been destroyed in the course of operations, *e.g.*, on the uterus. It takes the place of removal of the corresponding kidney, and where feasible is the operation of choice.

(A) *Vaginal Route.*—When done to cure a uretero-vaginal fistula, the operation consists essentially in freeing the lower end of the ureter from its surroundings and in suturing it into a small opening in the bladder. When freeing the ureter, a bougie or probe passed into it is a most valuable aid. The method of uniting the duct to the bladder will be described in the succeeding pages.

(B) *Superior Extraperitoneal Route.*—Expose the ureter by the lumbo-ilio-inguinal incision or a modification thereof. This is much less difficult to accomplish in the male than in the female, so far as the pelvic segment of the ureter is concerned; the broad ligament interferes considerably in the female.

'ransperitoneal Route with Extraperitoneal Uretero-y (Witzel's operation).—Open the abdomen by a incision in the hypogastrium. Incise the perito-er the iliac vessels, separate the peritoneum from acent structures by blunt dissection. The ureter ound united to the peritoneum and elevated with .e slight upward traction on the ureter to make nent and recognizable low down, in the broad . By a second incision in the broad ligament ex- ureter; divide it; ligate and cauterize the open-ie lower segment. Pull the upper segment up to of the original incision over the iliac vessels. With orceps guided behind the peritoneum to the side sical region "above the linea innominata," through iel under the peritoneum, draw the ureter down, tomose it to the bladder extraperitoneally. Close small wounds in the peritoneum. To make the osis without tension on the line of suture Witzel pulled the bladder towards the ureter and fixed it there, to the posterior parietes at the line of the peritoneal incision.

FIG. 780.—Van Hook's ureteral anastomosis.

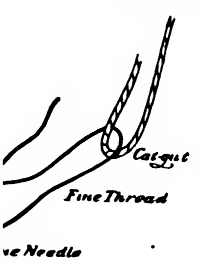

FIG. 781.

(D) *Intraperitoneal Route.*—This method has been used successfully in a number of cases and seems to be the method of choice when uretero-cystostomy is undertaken in the course of an abdominal operation in which the ureter has been divided. The end of the upper segment of the ureter must be found, if neces- the manner described in Witzel's operation, and of it separated from its surroundings to permit its ation to the bladder, without tension. To aid in roximation Witzel's plan of suturing the bladder to of the pelvis may be useful, but Kelly's procedure is Kelly detaches the bladder from the horizontal rami ibes and thus can bring the bladder to the ureter. ction of the ureter ought not to be too "clean" lest be threatened and necrosis result.

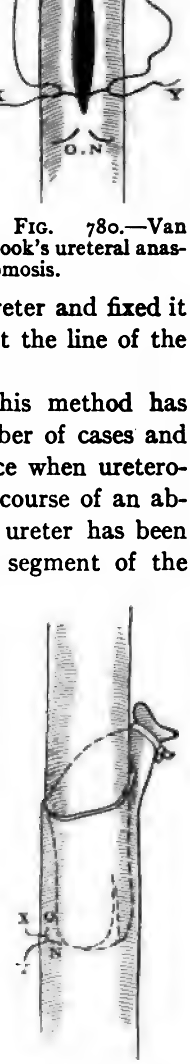

FIG. 782.—Van Hook's ureteral anastomosis.

ods of Uniting the Ureter to the Bladder.—(A) Pass through the urethra into the bladder and push its inst the bladder-wall at the place where it is desired the anastomosis. At this point ... bladder. has already been prepared ... g suture its wall. Catch the ends ... in the pull them into the blad... the the ... thra ...

neum for the passage of the forceps; in the female, the urethra serves). Traction on the suture pulls the open end of the ureter into the bladder and keeps it there temporarily. To prevent contraction of the open end of the urethra either cut it obliquely or split it as in the Van Hook operation for anastomosis. Carefully suture, with several tiers of suture, the outer coats of the bladder to the outer coats of the ureter in the Lembert fashion.

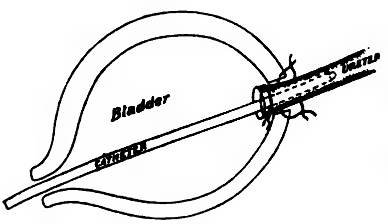

FIG. 783.—Uretero-cystostomy.

(B) This method is similar to the above, but a ureteral catheter is used in place of the forceps. Pass a ureteral catheter through the urethra into the bladder and bring its end out through an incision in the bladder at the site of anastomosis. Introduce the end of the catheter into the end of the ureter and tie it there with a fine plain catgut ligature (Fig. 783). Aided by traction on the catheter pull the end of the ureter into the bladder and fix it there by several layers of sutures introduced after the Lembert fashion. The ureteral catheter serves to drain the ureter and hold it in position until union takes place.

(C) *Van Hook Method.*—The end of the ureter is split to prevent subsequent stenosis. The operation is practically the same as in the case of uretero-ureterostomy, except that a line of Lembert sutures, burying the site of anastomosis and the one stitch which penetrates all the coats of the bladder, adds much security (Figs. 784, 785).

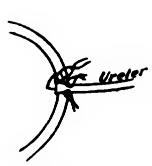

FIG. 784.

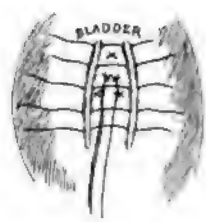

FIG. 785.

FIGS. 784 AND 785.—Uretero-cystostomy.

Implantation of the ureter into the intestine, preferably into the sigmoid, is carried out in the same fashion as into the bladder, but the results have uniformly proved disastrous, as infection invariably passes up the duct to the kidney. von Maydl's implantation of the ureters, plus a portion of adjacent bladder-wall, into the sigmoid does not belong to the same category and gives good results. It will be described in another chapter.

Union of the ureter to the skin is occasionally necessary, but the results are bad. Infection gains access to the tube and so to the kidney. The operation has its field of usefulness, however. When operating, *e.g.*, on a cancerous uterus, the ureter may be accidentally or intentionally divided; the condition of the patient may not admit of uretero-ureterostomy or uretero-cystostomy.

Under such circumstances it may be the best policy to fix the ureter to the skin and subsequently perform uretero-cystostomy.

It has been suggested that in all cases of ureteral anastomosis success is promoted if the corresponding kidney is exposed posteriorly, fixed to the lumbar region, and drained through a nephrotomy wound.

CHAPTER XLIX

OPERATIONS ON THE BLADDER

ECTOPIA VESICÆ (EXSTROPHY OF BLADDER)

Exstrophy of the bladder may be complete or incomplete. When incomplete, the case is usually one of non-obliterated urachus, and urine escapes from the umbilicus. This may be due to some mechanical obstacle to normal urination, and treatment must be directed primarily to removal of such obstacle (*e.g.*, phimosis). If spontaneous closure of the fistula at the umbilicus does not occur, the passage may be obliterated by application of the cautery or by excision.

Complete exstrophy of the bladder is a condition in which the anterior vesical wall and a corresponding portion of the parietes are absent. The anterior surface of the posterior vesical wall pouts forwards and the urine escapes at once as it leaves the ureters. As a part of the maldevelopment, one finds the pubic bones ununited and the penis in a condition of epispadias. Operations for the relief of ectopia vesicæ may be divided into five classes:

I. The formation of an anterior wall to the bladder by means of cutaneous flaps, the epidermal side being turned inwards to provide an epithelial lining for the viscus.

II. Union of the edges of the defect, thus providing a small cavity, but one lined by the bladder mucosa.

III. Formation of an anterior wall to the bladder from a segregated loop of intestine, thus providing a mucous instead of an epidermal lining.

IV. Excision of all the exposed bladder and transplantation of the ureters into the penile gutter.

V. Transplantation of the ureters into the intestine and excision of the bladder.

I. Wood's Operation for Ectopia Vesicæ.—Object of operation is to provide an anterior wall to the bladder and that such wall be lined with epithelium.

The Operation.—Flap A (Fig. 786) is made from the skin of the abdomen above the ectopic bladder and has its base near the bladder. In dissecting the flap from the subjacent tissues care must be taken to stop the dissection ***at least*** ¼ inch away from the edge of the bladder—*i.e.*, the hinge of flap A should be at least ¼ inch distant from the defect to be covered. The size of flap A should be greater than the defect to be covered. This is to allow for the shrinkage which always takes place in the flap. If it is desired to cover the dorsum of the penile groove with the same flap, then flap A may be extended upwards (the portion D of flap A D being used for this purpose). (Greig Smith.) Flaps B and C are obtained from the skin of the abdominal wall to the side of the bladder and of flap A.

The margins of the bladder are freshened by dissection except along the edge
osite the hinge of flap A, and where the penile groove or gutter enters the
dder. Flap A is turned downwards, the line being the hinge or line of turn-
, so that the epithelial surface faces the bladder and the raw surface is exter-
l. The edge of the flap is stitched to the freshened edge of the bladder. Spe-
l care must be taken in suturing the lateral margins near the base of the flap,
herwise union does not take place. flap C is dissected from the subjacent
sues and slid over the raw surface of flap A on one side (Fig. 787). The same
done with flap B. Both are sutured in position. The extensive raw surface
ft on the abdominal wall by the removal of flaps A, B, and C is diminished by
ding inwards the surrounding skin, and the remainder is covered by Thiersch's
in-grafts. If the extension D of flap A has been provided, then its edges are
itched to a line of freshening on each side of the penile gutter.

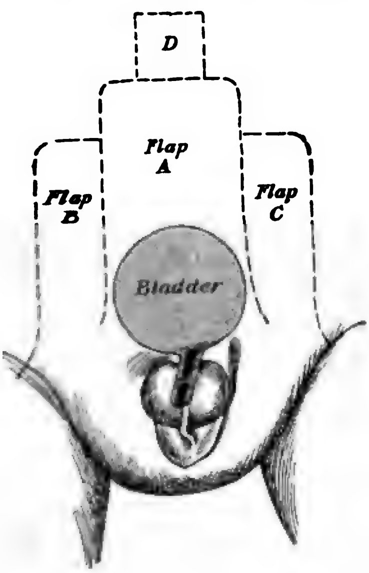

FIG. 786.

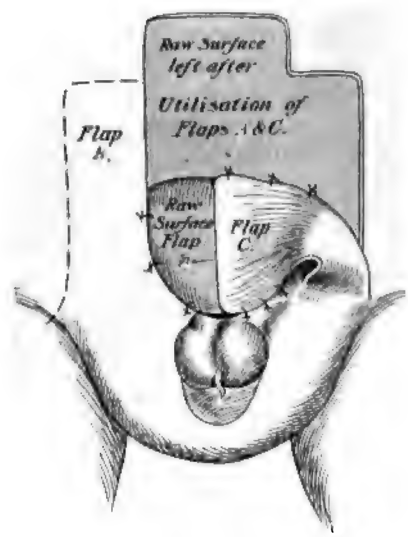

FIG. 787.

FIGS. 786 AND 787.—Wood's operation.

II. Trendelenburg's Operation.—Note, in cases of exstrophy, the pubic bones are not united at the symphysis. This want of union prevents immediate closure of the defect in the bladder and urethra. Trendelenburg overcomes the above difficulty as follows:

Make an incision about three inches in length over each sacroiliac synchondrosis. Open these joints and divide their ligaments and the interarticular cartilages. Press the anterior superior iliac spines together, so that the pubic defect is obliterated or lessened. Suture and dress the sacro-iliac wounds. Keep the pubic bones in apposition by means of suitable binders applied to the anterior borders of the pelvis. After the wounds have thoroughly healed, the exposed surface of the bladder may be seen lying at the bottom of a more or less

vertical groove, and may now have its edges freshened, mobilized, and united by sutures in the middle line.

This operation has given some excellent results.

J. W. Perkins, finding division of the sacro-iliac synchrondrosis too difficult and dangerous, divided the ilium close to the synchondrosis with the chisel and obtained the same result.

Trendelenburg informs the author that he has used this method of osteotomy but considers it more hazardous than his original procedure. (For much information as to the treatment of exstrophy, see Trendelenburg's paper in "Annals of Surgery," August, 1906.)

Schlange's Operation.—Schlange makes an incision along the outer edge of the lower part of each rectus muscle and loosens the muscle from its surroundings. He then, with chisel and mallet, divides the bony insertion of the muscle from the rest of the pubis and slides the mobilized insertion towards the middle

FIG. 788.—Exstrophy of bladder.

line, where he fixes it. The mobilization of the recti muscles permits of the approximation of the edges of the bladder and their union after freshening.

König ("Lehrbuch," ii, 634) has twice endeavored to close the pubic and vesical defects by one operation. He says: "I divided the horizontal and descending rami of the pubis through a small wound over the obturator foramen. This permitted closure of the defect in the symphysis when pressure was exerted on the pubis. The margins of the bladder and of the urethral groove were now freshened and sutured by two lines of stitches. Unfortunately, both patients succumbed." The principle of König's procedure seems admirable and its danger does not appear to the author to be intrinsically greater than that of some of the other methods the ultimate results of which are by no means brilliant.

Segond's Operation.—*Step* 1.—Make the incisions AB, DC, BC, around the ectopic bladder. The points A and D must not be at a lower level than the mouths of the ureters. Freshen the edges of the penile groove, E and F (Fig. 788).

2.—Dissect the ectopic bladder dowwards as a flap. The dissection be carried below the level of the ureteral mouths.

3.—Turn the bladder flap downwards and suture its edges to the corre- sides of the penile groove (Fig. 789).

4.—Make a transverse incision through the base of the malformed fore- . 789, X). By making the glans penis pass through the hole in the fore- atter is brought on to the dorsum of the penis and its tissue can be used the raw surface on the back of the new-formed dorsum of the penis.

tutkowski's Operation.—Rutkowski's operation and the similar one of have been used with more or less success in the treatment of exstrophy. ll be found sufficiently described in s devoted to repair of defects in the wall.

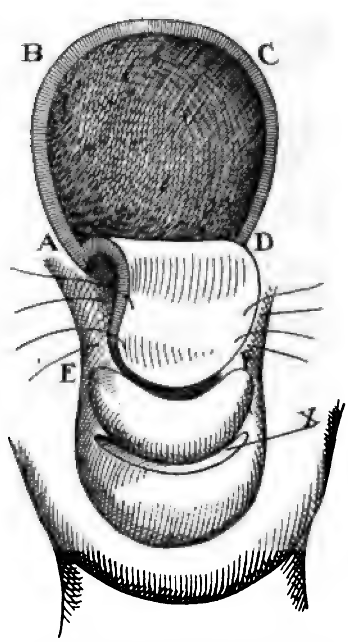

FIG. 789.—Segond's operation. (*Farabeuf.*)

onnenburg, in a case in which the ex- sical mucosa protruded greatly, and no urinal could be used, operated in wing manner: Make an incision all the exposed mucous membrane, and this cut dissect the mucosa from the al parietes, but do *not* injure the um. Remove the mucosa completely. the lower ends of the ureters from the ling structures sufficiently to permit plantation into the upper end of the which represents the urethra, and fix iere with sutures. Close the defect he abdominal wall by flaps slid over sides.

aydl's Operation.—Excise all the ex- sical mucosa except that portion im- y around the orifices of the ureters). Carefully cleanse the wound and peration after the excision of the filthy membrane. Open the abdomen. Find the sigmoid and bring a loop of the wound. By stripping, empty the gut of its contents. Apply an l clamp or tape above and below the part selected for anastomosis. ie gut longitudinally. With through-and-through sutures unite the the portion of bladder-wall attached to the ureters to the edges of the n the sigmoid (Figs. 791 and 792). Cover this line of suture by a line uous Lembert sutures. The result is that the remnant or ellipse of wall is inserted like a patch into the incision in the sigmoid. Note that separation of the lower ends of the ureters from their surroundings is the loop of sigmoid is brought down to the ureteral portion of blad- is, of course, mobilised, [illegible] lantat[illegible] he segment of blad- containing the ureters, [illegible] n of the ureters

themselves, is the important principle in the operation; by it the normal ureteral valves or sphincters are retained and infection is prevented from ascending the ureters. Several modifications of Maydl's operation have been suggested, but most of them merely complicate the technic.

VI. Makkas' Operation. ("Zentralblatt für Chir.," 1910, No. 33.)—To avoid the dangers of ascending infection inseparable from any method by which the ureters are made to discharge into a cavity containing fæces, Makkas excludes the cæcum from the rest of the intestinal tract, unites its cavity to the skin by means of appendicostomy and at a later date implants the ureters into the segregated cæcum using the appendix as a vent for the escape of the urine.

FIG. 790.—Maydl's operation.

The Operation.—*Stage I.*—*Step* 1.—Open the abdomen by an incision through the right rectus muscle.

Step 2.—Examine the cæcum. If the cæcum cannot be pulled to the middle line, mobilize it by incising the parietal peritoneum parallel and close to its outer side.

Separate the cæcum by blunt dissection from its posterior connections exactly as in cæcectomy but carefully preserve intact its blood supply.

Step 3.—Divide the ileum close to the cæcum and close both the distal and proximal segments of the gut, Fig. 793.

Step 4.—Divide the ascending colon above the cæcum and close both the proximal and distal segments of the colon.

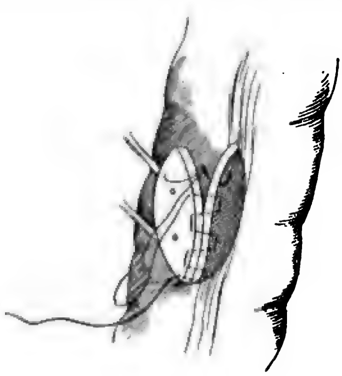

FIG. 791.

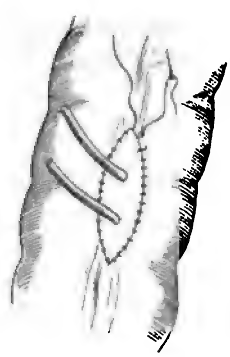

FIG. 792.

FIGS. 791 AND 792.—Maydl's operation.

Step 5.—Make a lateral anastomosis between the proximal segment of ileum and the distal segment of the colon (or the sigmoid).

Step 6.—Perform appendicostomy bringing the appendix out through a special opening. (Bringing the appendix out through an opening made by splitting the muscles of the abdominal wall as in the McArthur-McBurney operation would, it appears to the author, provide an excellent sphincter to the appendix.)

If appendicostomy seems inadvisable or impossible because of adhesions, small size of the appendix, etc., perform cæcostomy.

Step 7.— Close the abdomen.

After-treatment.—After the lapse of ten days pass a Nélaton catheter through the appendix daily and irrigate the cæcum.

Stage II.—This stage is practically identical with the Maydl operation except that the mobilized portion of the bladder-wall attached to the ureters is implanted into the lower part of the segregated cæcum instead of into the sigmoid. When the operation is completed the new bladder must be kept empty by a catheter introduced through the appendix.

In Makkas' case the catheter was clamped after eight days and the new bladder emptied every two or three hours. At first the capacity of the bladder was only 100 c.c. After four weeks the capacity increased to 300–325 c.c. and the bladder required to be evacuated every three or four hours through the day but not at all during the night.

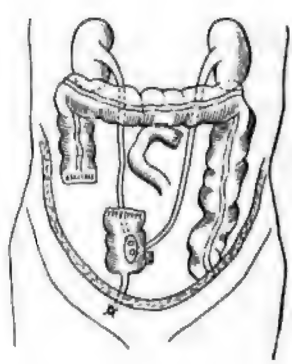
FIG. 793.—Makkas' operation. (*Makkas.*)

If the catheter was removed while the bladder was full there was no escape of urine, but this continence was not absolute as drops of urine escaped when the patient moved about. The urine was not albuminous but contained mucus. The necessity of leaving the catheter *in situ* permanently is a disadvantage, the lessening of the dangers of ascending infection is a great advantage over the Maydl method.

Cunéo's Operation.—("La Presse Med.," Jan. 10, 1912.) Open the abdomen. Choose a suitable segment of ileum and segregate it by dividing the gut at two places. Restore the continuity of the ileum by enterorrhaphy. Close the proximal end of the segregated segment. Low down on the anterior surface of the rectum make an incision through the rectal wall leaving the mucosa intact. From this incision make a tunnel passing between the mucosa and the anal sphincter to the skin. Push the open end of the segregated segment of ileum through the tunnel and suture it to the skin. After healing has taken place, implant the ureters with the trigone of the bladder into the segregated intestine. Cunéo's patient could retain urine for two hours during the day but was incontinent at night. The urine was normal.

Heitz-Hovelacque Operation.—This operation is identical in principle with Cunéo's and gives almost identical results. Open the abdomen. Divide the rectum at the level of the second or third sacral vertebra. Close the distal segment of gut. This forms the new bladder. Bring the proximal segment of gut downwards behind the new bladder separating the latter sufficiently from the sacrum. Implant the ureters in the new bladder. Make an incision through the musculature of the back of the new bladder and form a tunnel to the skin between the mucosa and the anal sphincter. Pull the mobilized upper

segment of rectum (or pelvic colon) through the tunnel and suture it to the skin. The result of this operation was almost identical with that of Cunéo. It is *said* that there was no escape of gas or fæces during urination.

Remarks.—The great objection to all operations which endeavor to reconstruct the bladder, whether by the use of skin-flaps, by the union of the edges of the imperfect viscus, or by the implantation of a segregated loop of intestine, is that the result is merely the formation of a urinary receptacle which is devoid of any sphincter and hence cannot retain the urine. The only advantages to be obtained by such operations are the protection of the vesical mucosa from injury and the direction of the urine towards the penile gutter, where it is more feasible to attach a portable urinal. The operation of excision of the imperfect bladder and transplantation of the ureters into the penile gutter possesses both these advantages, and is perhaps a better procedure than any of those which seek to reconstruct the bladder. In performing plastic operations such as those described it is very difficult to obtain complete union of the transplanted flaps to their surroundings—hence fistulæ occur which, unless closed, nullify the operation. One very grave objection to the plastic operations which provide the new bladder with an epidermal lining is that urinary salts are inevitably deposited on the bladder-walls and cause much distress. No matter how carefully the flaps have been selected, fine hair is liable to grow on them and give rise to complications. *Prima facie*, one would think that when the new bladder is lined with true mucous membrane, as in Rutkowski's operation, the danger from calculus deposits would be obviated, but experience shows this not to be true; hence the same objection obtains.

When simple uretero-sigmoidostomy or uretero-colostomy is performed, infection inevitably passes up the ureters and leads to a fatal issue. Maydl's idea that transplantation of the ureters, plus their sphincteric attachment to the bladder-walls, avoids the danger of infection ascending from the gut seems correct and is the operation of choice. The lower gut is, or becomes very tolerant to the presence of urine, and the anal sphincter is capable of retaining the urine for a very respectable length of time.

Operative Treatment of Rupture of the Bladder.—The diagnosis of rupture of the bladder from the symptoms alone is not always possible before it is too late to be of aid in treatment. Other or operative means of diagnosis are often essential.

Diagnosis by Operation.—When the patient has overcome initial shock (twelve to twenty-four hours), or immediately if his condition warrants, diagnosis by operation may be attempted.

I. Injection of air or water into the viscus. By injecting air or water into the bladder, should the viscus be ruptured, no globular tumor will form over the pubis, and when the water is allowed to flow back, much less will return than was injected. Should there be no rupture, the distended bladder will be easily found in its normal site.

The above operation has often served a good purpose, but Schlange points out that the water or air introduced under pressure is liable to cause separation

of peritoneum from the bladder along a ragged rupture—quite a serious objection. The same objection holds good against cystoscopic examination. Another objection which might be urged is that in the case of an extraperitoneal rupture the air or water might easily distend the bladder to its normal limits and so lead to mistake.

II. Several surgeons have recommended perineal section and examination of the bladder through the wound. This has but few advantages over the next method, and is possessed of many disadvantages.

III. Suprapubic cystotomy. Without the aid of rectal distention the surgeon cuts into the bladder above the pubis. Under the special circumstances (empty bladder, etc.) much care must be taken to "hug" the pubis. The bladder having been opened, the finger soon discovers any ruptures of its wall.

If intraperitoneal rupture is present, the skin-wound is enlarged upwards and the belly opened. Any bloody urine in the peritoneal cavity is gently sponged away. It may now be necessary to put the patient in the Trendelenburg position. The ragged wound of the bladder is examined, and if necessary, some of its bruised edges trimmed away. A line of chromicized catgut sutures is put in place. These sutures pass through all the coats of the viscus except the mucosa. A line of Lembert sutures is inserted superficially to protect the deep ones. The abdominal cavity is now cleaned, either by flushing with normal salt solution or by gently sponging with gauze pads. The laparotomy wound is closed with or without drainage.

In extraperitoneal rupture the danger is, of course, from infiltration of urine. The suprapubic cystotomy guides the surgeon to the threatened or affected regions and he can at once provide free drainage by appropriate incisions and by packing such regions with iodoform gauze. Bleeding must be stopped either by ligature, pressure, or packing.

How ought the suprapubic wound of the bladder to be treated? In such cases it ought always to be left open. Schlange unites the vesical mucous membrane to the skin by a few stitches. The bladder itself is lightly filled with iodoform gauze, so that it is constantly emptied of urine by capillary drainage. Permanent catheterization of the ureters and packing of the bladder is a tempting procedure which would be liable to lead to ureteritis and pyelitis.

Suprapubic Cystotomy.—The operation of suprapubic cystotomy may be required for the removal of calculi or neoplasms from the bladder, for the removal of enlarged lobes of the prostate, for purposes of exploration and the treatment of various vesical lesions, and for the carrying out of retrograde catheterization, etc. Preliminary treatment varies according to circumstances—in one case, *e.g.*, prostatectomy, it is wise to endeavor to cleanse the bladder by appropriate means; in another case, *e.g.*, bleeding villous tumors, such treatment is calculated to encourage serious hemorrhage; in cases of cystitis where treatment *per urethram* is a failure, the cystotomy is undertaken to provide drainage, and the failure of other treatment means failure to cleanse the bladder. In all cases the large intestine should be well emptied before operation. Local or general anesthesia is requisite.

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Shave the pubis and cleanse the hypogastrium and the penis. Introduce a catheter and irrigate the bladder with warm salt, boracic acid, or Thiersch's solution. When the irrigation is finished, distend the viscus with the solution or with air. Remember that in cases of old cystitis the bladder-wall is often very weak and cannot safely be greatly distended. A good plan is to test the capacity of the bladder before any anesthetic is administered and act according to the knowledge gained. Many surgeons prefer air distention to fluid. Air is said to bring the viscus more easily against the abdominal wall, and when the bladder is opened, there is no gush of infected fluid over the field of operation. These advantages are of no great value and most surgeons prefer the warm aqueous solutions, which are more easily sterilized and managed than is the air. Air distention has led to several catastrophies. Having distended the bladder within the limits of safety, withdraw or plug the proximal end of the catheter and tie a rubber band around the penis to prevent the escape of the water or air, If the catheter is left *in situ*, it acts as a guide to the bladder.

Some surgeons endeavor to lift the bladder still more against the belly-wall by inserting a rubber bag into the rectum and distending it with air or water. This procedure is unnecessary and has led to many serious injuries being inflicted on the rectum. Even distention of the bladder itself is not *absolutely* necessary, but when possible, is always of immense value, as it pushes the vesical fold of peritoneum upwards and makes the extraperitoneal exposure of the bladder easy.

Place the patient in the Trendelenburg position, as this enlarges the extraperitoneal area through which one must proceed.

I. *Vertical Incision.*—Beginning on the pubis near its upper edge, make a vertical median incision upwards for from 3 to 4 inches. Expose and divide the anterior layer of deep fascia and separate the pyriform and recti muscles. Carefully pick up and divide the deep layer of fascia, thus exposing the prevesical fat. Hook the finger behind the pubis and pull upwards the prevesical fat, and with it the vesical fold of peritoneum. Recognize the peritoneal fold and retract it upwards out of danger. Rarely the peritoneal fold may be adherent to the pubis and must be freed by blunt or sharp dissection. During the manœuvres described the peritoneal cavity may be accidentally opened. This accident is only important if not promptly recognized and corrected by a few carefully placed sutures. Expose the anterior wall of the bladder by bluntly dissecting through the fat in front of it. Once the peritoneal fold is recognized and retracted, do not hug the posterior surface of the pubis too closely, as to do so means exposure of the bladder at a level difficult of access and where it is very vascular; it also means the formation of a ragged pouch difficult to drain, in very unresisting tissues. The nearer its dome the bladder can be exposed extraperitoneally, the better. The bladder will be recognized by its globular form, if distended, or by the catheter in it if it is not distended. It has a brownish-red color, and one can see the longitudinal fibres of the detrusor muscle on its surface.

The bladder having been *freely* exposed, pick up a portion of its wall with

a sharp hook or volsellum, and with a strongly curved needle pass two long sutures through its walls parallel to the direction in which it is desired to incise the bladder. These sutures serve as convenient tractors. Jacobson omits their use, as he thinks they do more damage than forceps attached to the edges of the incision. The writer has never seen harm result from the thread tractor, and they are certainly much more convenient than forceps, which always impede further operative work. Incise the bladder, either vertically or transversely, sufficiently to admit one or two fingers. The transverse incision is the better; it is more readily enlarged and more readily closed. If the vertical incision is chosen and requires enlargement, such enlargement must be done downwards in an awkward location, deeply behind the pubis. If for the purposes of the subsequent steps of the operation (removal of calculi, tumors, etc.) the wound in the parietes is found too narrow, more space may be obtained by making a number of small incisions or nicks in the edges of the recti muscles, or those muscles may be separated from their pubic insertion. More room has also been obtained by subperiosteal excision of part of the pubic bones. Such extreme measures to gain space are rarely necessary.

The treatment of the various lesions met with in the bladder will be discussed later.

Treatment of the Wound in the Bladder.—If the bladder is not seriously infected or the wound has not been greatly contused, *e.g.*, by the removal of stones, etc., the opening may be closed in whole or in part. If marked vesical infection is present, or if the walls are much contused, it may be necessary or judicious to leave the wound wide open.

Closure of the Vesical Wound.—If the mucosa is inclined to bleed, unite the edges of the wound in it by a row of continuous fine catgut sutures. With fine catgut on a rounded needle (one without cutting-edges) unite the edges of the wound in the muscular wall of the bladder. If it can be accomplished without undue tension, bury the layer of muscle suture by a row of stitches inserted in the Lembert fashion and composed of fine silk or celluloid hemp. It is very desirable to have an inverted wound with wide surfaces in apposition. Close the wound in the parietes after providing tubular or cigarette drainage for the prevesical space. If the bladder is completely closed as above, urine must be drawn off frequently by the catheter or permanent catheterization must be kept up. It is a very good and eminently safe precaution to provide perineal drainage before closing the vesical wound. This may be done as follows: Through the suprapubic opening pass a closed forceps through the internal meatus into the membranous urethra. Place the patient in the lithotomy position. With the forceps above mentioned make prominent the membranous urethra just behind the bulb. Cut down on the point of the forceps and with them seize and pull into the bladder the end of a soft-rubber catheter (No. 36 Fr. or larger). With a stitch fix the catheter to the perineal wound. Proceed with the closure of the suprapubic wound.

If it is desired to establish suprapubic drainage, partially close the wound, if it is too large, and introduce into the bladder a 1/4-inch rubber tube or even

two such tubes. The ends of the tubes should not impinge against the base of the bladder and they should be cut so as to be bevelled and be provided with lateral openings. In such cases it is wise to sew the bladder to the parietal fascia around the point of exit of the tubes. This is to prevent leakage of urine into the abdominal wound. When the vesical wound is not large and drainage is desired, one may proceed as follows: Dress a ¼-inch rubber drain by covering it with two or three layers of gauze; this in turn covered by rubber tissue (practically a cigarette drain with a tube through its centre). Introduce the end of the drain a very short distance into the bladder. With catgut suture the edges of the bladder wound to the drain or its dressing. Push the tube a little further into the bladder; this inverts the edges of the bladder wound. In the Lembert fashion, with catgut, suture the surface of the bladder all around the wound to the tube. We thus have a double line of sutures (catgut) uniting the bladder to the tube and forming a water-tight joint. Fix the ends of the last row of sutures to the parietal fascia so as to keep the bladder in contact with the abdominal wall and close the wound in the latter. The water-tight joint around the tube is intended to keep urine and infection away from the prevesical fat and the abdominal wound until healing has progressed, to some extent, at least.

If from any cause it is deemed proper to leave the vesical wound entirely open, it is wise to attach its edges to the fascia abdominalis by a few points of suture, and to pack its cavity loosely with iodoform gauze.

It is easy to attach, with a glass joint, a long piece of tubing to the bladder drain and by siphonage conduct the urine to a suitable receptable placed beneath the bed.

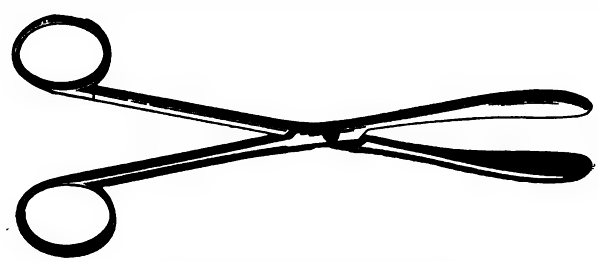
II. *Transverse Incision*.—Bardenheuer and many other surgeons prefer a transverse to a vertical incision, as more room is obtained. The disadvantage of this method is the liability to subsequent hernia. In cases of intravesical tumor the transverse incision is specially good. Place the patient in Trendelenburg's position. Make a slightly curved horizontal incision through the skin from the neighborhood of one external inguinal ring to the other, immediately above and parallel to the pubic bones. Divide the fascia covering the recti muscles. Separate the recti, pyramidales, and the linea alba from the bone. The retraction of the muscles gives a wide space for the subsequent work; if more space is required, separate the recti from each other vertically. The rest of the operation is the same as that already described.

Suprapubic Lithotomy.—This operation is practically that of cystotomy plus the removal of the stone. If the calculus present is believed to be large, the transverse incision is the better, as it gives more room. It is bad practice to drag a stone out through too small an incision, as the resulting trauma is far more noxious than the making of a large opening by a sharp, purposeful cut. Calculi must be removed by appropriate forceps or scoop (Figs. 794 and 795). In the absence of these special and very convenient instruments, common sense informs us that the same object may be attained, though less expeditiously, by the use of the fingers, ordinary forceps, or a loop of wire. The suprapubic route

sures a good survey of the interior of the bladder, and hence prevents the not common fault of overlooking a second or third stone. Remember that a cond calculus may lie encysted in the pouch behind the prostate. When there no great infection present, it is good practice to establish perineal drainage in e manner already described and close the suprapubic wound. If infection is nsiderable suprapubic drainage ought to be established, either alone or in mbination with perineal. The after-treatment consists in keeping the bladder lean; the cystitis usually quickly subsides on removal of its cause.

Occasionally the stone may lie in a congenital or acquired diverticulum. If his is the case Fenwick advises fragmentation of the stone *in situ* by means of a chisel lightly struck by a mallet. In one case where the stone was unintentionally broken the author found great difficulty in removing the fragments. In another case where a stone, 3¾ x 1¼ x 1½ x 2¾ inches in diameter, lay in a diverticulum the mouth of which was only large enough to admit the forefinger, forcible dilatation of the opening permitted removal of the calculus, hemorrhage was trivial, and no evil seemed to result. (Excision of vesical diverticula, see page 710.)

Suprapubic Cystotomy for Benign Neoplasms.—Benign neoplasms are usually pedunculated; they may be single or multiple, sometimes being very numerous, filling up most of the space in the bladder. Most vesical papillomata bleed easily, and on account of this tendency it may be convenient to throw into the bladder, im-



. 794.—
tomy scoop.

FIG. 795.—Lithotomy forceps.

liately before operation, a small quantity of a solution of adrenalin. e advantage gained by the use of adrenalin is that less bleeding occurs ring the active operation, and hence the surgeon sees better what he is ing; whether hemorrhage is more or less liable to occur secondarily, *i.e.*, ter the effects of the drug have worn off, is another matter, and not yet roved.

The bladder is opened preferably by the transverse incision, because of the ree access obtained. When the tumor is pedunculated, seize its base in a curved clamp and cut away the free portion of the growth. Never drag upon the forceps so as forcibly to tear away the growth. Sometimes the tumor is so delicate that mere pressure with the for[illegible]ates it from its base. When

possible, excise with scissors the portion of the pedicle grasped by the forceps and close the wound in the mucous membrane with one or two points of catgut suture. The finger of an assistant pushing up the bladder from the rectum may aid greatly in this work when the site of the trouble is on the posterior bladder-wall. If the tumor is sessile or has a broad base, cut it away with scissors, as close to the bladder-wall as possible, and cauterize the stump with the thermo-cautery. Some surgeons operate on tumors and various bladder-lesions through a kind of coffer-dam, so as to avoid urine and blood from other parts obscuring the field of operation. The model on which all such coffer-dams are made is the old Ferguson's tubular vaginal speculum, passed through the abdominal wound and enclosing in its distal opening the area to be attacked. The coffer-dam undoubtedly is a great aid in operating, but it has the serious disadvantage of requiring, for many purposes, the use of special scissors and forceps to permit of work being done through its narrow lumen. After the removal of tumors drainage is essential, and the use of various antiseptic and more especially astringent douches is advantageous. Repeated operations may be necessary before all the neoplasms are removed. If hemorrhage is alarming, the bleeding areas may be packed with iodoform gauze.

Nitze and Sonnenburg write as follows ("Handbuch der practischen Chir.," iii, 838): "Passing one or two fingers gently into the bladder, one informs himself as to the nature of the tumor and the manner of its origin on the bladder-wall. If, as is very common, the tumor is a large, solid, villous growth with a pedicle, or if a pedicle can be formed by cautious pulling on the tumor, catch it gently but firmly between the fore- and middle fingers and pull it upwards from the mucous membrane for such a distance that a curved forceps or clamp can be applied to the pedicle between the fingers and the mucosa. By careful, but strong traction on the locked forceps, endeavor to bring the base of the tumor up to the level of the external wound. It is astonishing how far up continued traction can bring the mucous membrane of the base of the bladder without injury to the patient. If the tumor is large, it often prevents ocular inspection of the mucosa around its base and the necessary recognition of the ureteral openings. Under these circumstances one tears away the villous masses from their pedicle; no hemorrhage results because the forceps are *in situ* compressing the pedicle. The whole field of operation being exposed to view, pass two silver wires through the portion of bladder-wall that is pulled up by the forceps, at a considerable distance from the pedicle, and then with the knife or cautery (knife-blade) excise the pedicle, and with it some of the surrounding mucosa. Injury to the ureters can usually be avoided during the extirpation of benign neoplasms even if the latter are situated at their orifices, but their injury generally does no harm; even complete excision of the ureteral orifices is well borne. After extirpation of the base of the tumor the silver wires already in place prevent retraction of the field of operation and thus hemorrhage can be more readily attended to, and sutures introduced, after which the silver wires are removed."

Malignant neoplasms cannot be efficiently treated in the above fashion.

All nibbling, hesitating methods are worse than useless, merely stimulating to increased rapidity of growth. The principles of operation are identical with those for operation on carcinoma located elsewhere, viz., wide and complete removal, partial or total cystectomy.

The most serious form of non-malignant ulcer of the bladder is the tuberculous, and this will be taken as the type in discussing the operative treatment of ulcer. As in other locations, so also in the bladder rest is a *sine qua non* of treatment. Drainage through the suprapubic, the perineal, or through both routes is the best means of obtaining the necessary rest, and in cases of simple ulceration may be essentially all the treatment required. When the ulceration is tuberculous, further operative treatment is necessary. Open and explore the bladder. A cold electric lamp introduced through the wound is a great aid, as also is light from a head-mirror or lamp. If the ulcer is solitary, limited in extent, and situated on the anterior part of the bladder from which the peritoneum can be stripped, it is wise to excise the affected portion of vesical wall and close the wound completely after providing perineal drainage. If the ulcer is situated at the base of the bladder—and this is commonly the case—cauterize it with the thermocautery or with pure formalin and rub iodoform into it. The subsequent local treatment must consist of drainage and lavage with suitable antiseptic lotions. General treatment is of the utmost importance—good food, fresh air, tonics, and some form of guaiacol are our main reliances.

The natural resisting power of the bladder against tuberculosis is well illustrated in cases of tuberculous nephritis and ureteritis in which secondary lesions appear in the bladder around the ureteral orifices. After nephrectomy and ureterectomy the vesical lesions often disappear spontaneously. This fact encourages us in the treatment of vesical tuberculosis.

Suprapubic Prostatectomy and Prostatotomy.—Open the bladder and explore so as to recognize the variety of prostatic enlargement present and the presence or absence of vesical calculi. If the latter are present, remove them.

I. *Enlarged Pedunculated Middle Lobe.*—This lobe may be the sole obstacle to urination, forming a valve which occludes the vesical meatus.

Method A: Cut through the pedicle with scissors and remove the lobe. Hemorrhage is easily controlled by temporary pressure with pads wrung out of hot water.

Method B: Incise or tear through the mucosa covering the lobe and shell it out with the finger. This method is available whether the hypertrophied lobe is pedunculated or not.

Never omit to examine the prostatic urethra, lest the lateral lobes impinge upon it and require removal.

II. *Enlarged Lateral Lobes with or without Enlargement of the Middle Lobe.*—Introduce a gum-elastic catheter into the bladder through the urethra, to act as a guide to the position of the prostatic urethra. Make an incision through the mucous membrane over the most prominent part of the swelling. With the finger, aided if necessary by closed blunt-pointed scissors, peel the mucosa

from the surface of the prostate. Insinuate the finger through the mucosal wound, between the prostate and the urethra, and separate these structures. In the same way separate the outer surface of the prostate from its surroundings, the finger passing between the true and false prostatic capsules. The fingers of an assistant should be passed through the anus to elevate and steady the prostate. Working as above, the prostate may be removed in one piece or in two or more sections. Freyer is often successful in leaving the prostatic urethra intact, though when it is injured no harm seems to result. Moynihan removes the prostatic urethra with the gland. It is claimed that when the two lateral lobes are removed separately the ejaculatory ducts are not destroyed. The author for a number of years has omitted the use of any catheter or sound as a guide. He introduces his finger through the suprapubic wound into the internal or vesical meatus, with his finger nail penetrates the mucosa and shells out the enlarged lobes. In this procedure he has the support of L. L. McArthur ("Surg., Gyn., Obst.," Ap. 10, p. 412). Hemorrhage is easily controlled by temporary pressure with pads wrung out of hot water. Freyer introduces a large drain into the bladder through the abdominal wound and sutures the vesical wound around it. Through the tube irrigation with hot water may be practised and any blood-clots removed. The drain is kept in position for about one week, when it is removed and the wound permitted to close. Very excellent results have been reported from this apparently severe operation. Fuller, after completing the enucleation of the prostate, establishes perineal drainage and closes the suprapubic wound. In cases in which there is much infection it is probably best to maintain both perineal and suprapubic drainage for a few days. Prostatectomy via the perineal route will be described on another page.

W. E. Lower (Annals Surg., Feb., 1914) strongly recommends Crile's anociassociation in prostatectomy as it eliminates shock. He operates as follows:

One hour before operation give a hypodermic injection of morphine and scopolamine.

Immediately before the operation irrigate the bladder and inject 60 to 90 c.c. of a 5 per cent. solution of alapin through a catheter which is then clamped and left *in situ*.

Administer nitrous oxide and oxygen.

Perform suprapubic cystotomy after infiltrating the skin and all the tissue planes as well as the bladder-wall with a 1/4 per cent. solution of novocaine.

Gently retract the wound in the bladder with four suitable retractors and inject the prostatic capsule with the novocaine solution.

Enucleate the prostate. N. B.: The catheter is still *in situ*.

Push the vesical mucosa which covered the prostate down into the cavity left by the enucleation, so that the vesical mucosa meets the urethral mucosa. Keep the mucosa in position by narrow strips of gauze packed over it and around the point of the catheter. The ends of the gauze come out through the vesical wound.

Cystectomy.—Cystectomy may be partial or complete.

Partial Cystectomy.—This operation is most commonly indicated in cases of circumscribed malignant neoplasm, and whenever feasible should be carried out extraperitoneally. The anterior wall, most of the fundus, and sometimes even part of the posterior wall of the bladder may be exposed without opening the peritoneal cavity. Expose the bladder as in suprapubic cystotomy. Carefully pull the prevesical fold of peritoneum upwards, and by blunt dissection separate its vesical layer from the bladder to the desired extent. If the peritoneum is accidentally torn, the tear must be at once closed with sutures. Having exposed the bladder at the site of the tumor (anterior wall or fundus), open it and remove the whole thickness of the diseased portion, making the necessary cuts in healthy tissue. Remove too much rather than too little tissue along with the neoplasm. Close the wound by sutures exactly as in suprapubic cystotomy, after providing for drainage—preferably through the perineum.

If the neoplasm has infiltrated the bladder-wall so as to attack the peritoneal covering and its location is favorable, the operation may still be accomplished practically extraperitoneally. Expose the bladder and reflect the peritoneum from it except where it is adherent over the site of the neoplasm; with scissors cut around the site of adhesions; with sutures close the gap in the peritoneum and remove the diseased cystic wall as already described.

When the disease affects the posterior bladder-wall, but does not infiltrate the peritoneal covering, it may be removed as follows: Apply a solution of adrenalin to the bladder so as to control hemorrhage, not from any fear of loss of blood, but to keep blood from obstructing the view. Incise the bladder-wall all around the neoplasm, cutting in healthy tissue. Cut down to but not through the peritoneal coat. Remove the disease, along with the whole thickness of the wall, minus the peritoneal covering. Close the wound by a layer of sutures (catgut) involving the muscular coats alone, and one involving the mucosa alone. Should the peritoneum be accidentally opened, close it at once by a few catgut or fine silk sutures. The operation as above described involves more precise suturing than most surgeons are capable of doing. It must require marvelous skill to suture *with precision* the various vesical coats when the work has to be done at the bottom of a deep cavity. If the peritoneal covering is uninjured, probably the best method to pursue is to make the stitches involve the muscular and mucous coats. These stitches will probably not secure complete union; there will be separation of the edges in time, but they will lessen the size of the defect and so hasten recovery. If it is possible to pull the wound up towards the surface of the body, then of course its closure is easy.

When the tumor is situated at the trigone, the operation is very much as above described. One cuts through the bladder-wall layer by layer until the perivesical fat is reached, and then removes the disease. If the ureter is involved in the disease, pass a catheter into it and dissect it free from its surroundings for about two inches; remove such part of it as may be diseased; secure its ends temporarily by a thread. After the resection of the bladder-

wall is completed unite the ureter once more to the bladder. Occasionally it has been necessary to anastomose the ureter to the rectum or skin; this is very undesirable.

Transperitoneal Partial Cystectomy.—Francis Harrington ("Annals Surg.," 1893), struck by the safety with which wounds of the bladder, accidentally inflicted during laparotomy, may be sutured, boldly opened the bladder through

FIG. 796.—Partial cystectomy. (*Mayo.*)

the peritoneal route. C. H. Mayo followed Harrington with a number of successful operations for vesical neoplasms.

The Operation.—Wash out and empty the bladder completely. Put the patient in Trendelenburg's position.

1. Make a median incision between the pubis and umbilicus about 6 inches long. Open the peritoneum. Thoroughly pack with gauze to keep the intestines away and to protect the belly cavity.

2. Pick up the bladder with two volsella and incise it between them. The incision is median and about 2 inches in length. With gauze mop out any fluid in the bladder. Enlarge the incision in the bladder upwards and downwards until the cut equals one-third or more of the vertical circumference of the viscus.

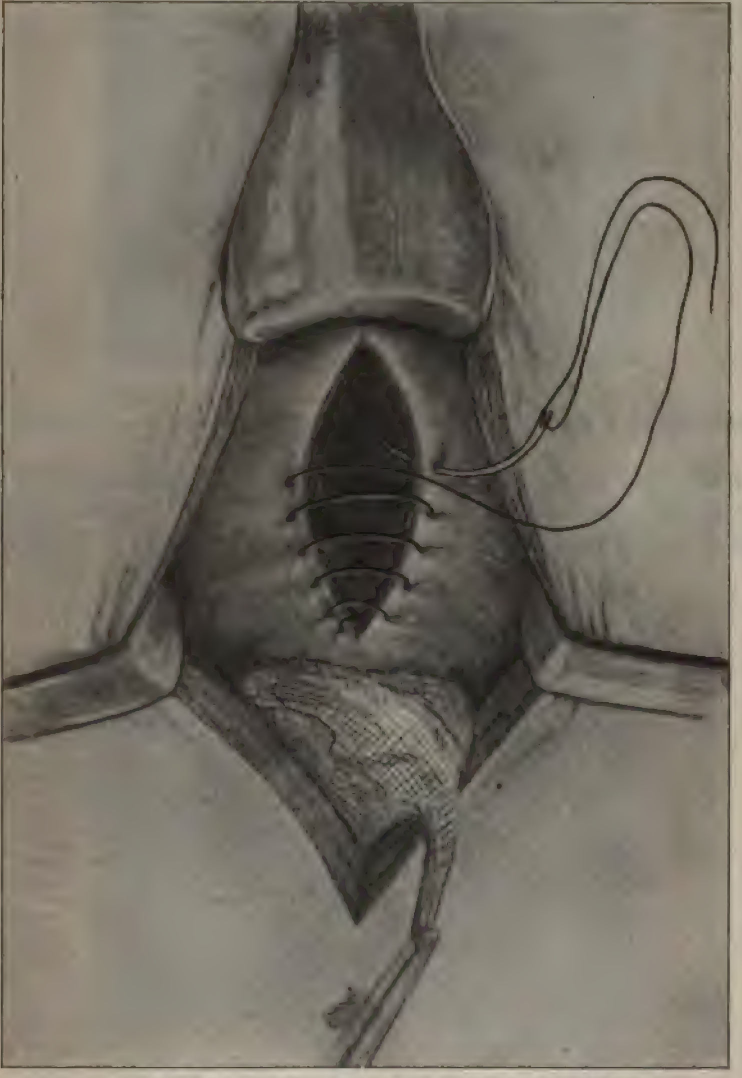


FIG. 797.—Partial cystectomy. Suture of bladder. (*Mayo.*)

3. If the tumors are pedunculated and benign, cut through them flush with the vesical mucosa and burn the wound with a cautery (Fig. 796).

If the tumors are sessile and benign, remove them and burn their site.

If the tumors are malignant, excise them with the mucosa by means of the

cautery knife. Do not try to destroy the growth with the cautery, but lift it up with forceps and dissect it away, using the cautery as a knife.

4. Close the wound in the bladder by through-and-through catgut stitches

FIG. 798.—(*Squier and Heyd., Surg., Gyn. and Obst.*)
Exposure of prevesicle space. Urachus and divergent obliterated hypogastric arteries held taut by intestinal forceps.

introduced in the Connel fashion (Fig. 797). Put in a second layer of stitches (hemp) in the continuous Lembert or Cushing fashion. At the lower end of the cut, where the bladder is not covered with peritoneum, it is easy to so loosen

FIG. 799.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Exposure of left ureter by blunt dissection along the course of left obliterated hypogastric artery.

the parietal peritoneum continuous with the vesical peritoneum that it can be made to lie on the bladder and permit the continuation of the Lembert suture until the bladder is completely closed. Usually no drainage is required, but should cystitis, etc., demand drainage, provide for it in the following manner:

(*a*) Bring about 1 to 1½ inches of the lowest part of the parietal peritoneum on the left side of the abdominal wound over to the right side of the vesical wound and fix it there by a few catgut sutures.

FIG. 800.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Exposure of left ureter by blunt dissection along the course of the left vas deferens.

(*b*) Make a stab wound in the bladder about ¾ inch to the right of the lower end of the vesical wound. Introduce a split rubber tube containing a strand of gauze into the bladder and bring it out through the lower end of the abdominal wound. With fine catgut, suture the parietal to the vesical

FIG. 801.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Final separation peritoneum from bladder, exposing both ureters, vasa deferentia and upper pole of trigone.

peritoneum just external to the stab wound in the bladder and continue this stitching so as to unite the parietal to the vesical peritoneum just above the line of the drainage tube.

The object of this elaborate method of drainage is to avoid (*a*) contamination of the belly cavity with urine escaping along the drain; (*b*) contamination of the line of Lembert sutures.

FIG. 802.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Bladder pulled down towards symphysis. Primary incision in bladder.

5. Close the abdominal wound. If drainage is not used, draw off the urine with a catheter as may be necessary; commonly the urine is voided voluntarily. If drainage is used, the dressings must be removed frequently.

FIG. 803.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Bladder wound enlarged downwards

An account of Young's method of partial cystectomy is given in the section on Excision of the Seminal Vesicles.

Squier-Heyd Operation (Surg., Gyn. and Obst., July, 1914).—*Step* 1.—From a point one inch above and to the left of the umbilicus make an incision downwards

to a point two inches above the pubis in the middle line. Open the peritoneum. Place the patient in the extreme Trendelenburg position. Push the intestines towards the diaphragm. Thoroughly isolate the field of operation with gauze pads.

FIG. 804.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Bisection posterior wall bladder.

Step 2.—Continue the incision downwards through the skin and fascia. Divide the pyramidales transversely at the pubis. Expose the prevesical space but do *not* interfere with the pubo-vesical attachment at any stage in the operation.

FIG. 805.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Neoplasm and affected ureter excised, *en masse* with much healthy tissue. Hemostasis with angled forceps. Temporary ligature around proximal ureter.

Step 3.—At the lower angle of the peritoneal incision catch the urachus and peritoneum with a forceps protected by rubber tubing (Fig. 798). Pull on the

forceps upwards and make prominent the obliterated hypogastric vessels (hypogastric cords).

Step 4.—Pull the left hypogastric cord upwards and to the right. By blunt dissection between the cord and the lateral wall of the pelvis, expose the left vas deferens as it runs along the pelvic wall to the inner side of the hypogastric cord (Fig. 799).

Step 5.—Exert gentle traction on the exposed vas, and dissect bluntly downwards along it until the pelvic ureter is exposed as it bends inwards above the fascia of the pelvic floor to enter the bladder. At this point the ureter is crossed on its inner side by the vas (Fig. 800).

Repeat Step 4 and 5 on the right side.

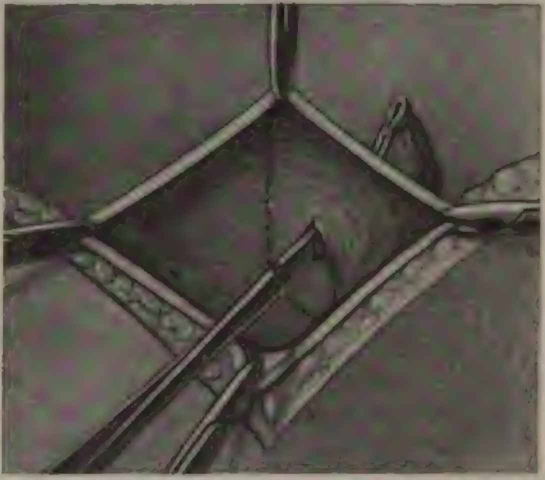


FIG. 806.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Partial closure of bladder wound. Stab wound for implantation of ureter. Forceps grasping ureter.

Step 6.—Divide the urachus close to the bladder (Fig. 801). Strip the peritoneum from the bladder until the recto-vesical space is reached. Push Douglas' cul-de-sac upwards and backwards. Pull the bladder downwards towards the symphysis until the upper poles of the seminal vesicles are exposed. The whole fundus of the bladder and the upper portion of the trigone are fully exposed. The ureters are constantly in sight. There is little bleeding.

Step 7.—Carefully unite the denuded lamella of the peritoneum to the upper end of the abdominal incision so that all the subsequent procedures are extra-peritoneal.

The rest of the operation is sufficiently described by Figs. 802–809 with the legends under them.

Squier and Heyd note that fifteen patients were operated on by their method in two years with no operative mortality.

"In the last three the technique was carried out without entering the peritoneal cavity, thereby making the operation entirely extra-peritoneal.

In addition, approximately the same technique has been utilized for removing calculi at the lower end of the ureter and for an extensive resection for diverticulum of the bladder."

Rutkowski's Operation for the Repair of Defects in the Bladder-wall.—Scope of operation: Rutkowski's operation may be used to close the bladder in cases

FIG. 807.—(*Squier and Heyd, Surg., Gyn. and Obst.*) Implantation of divided ureter after partial closure of the bladder.

of ectopia. It also promises to be useful in repairing the bladder after the removal of tumors. In describing the operation it will be assumed that the case is one of tumor.

The Operation.—1 Open the belly by a 4-inch incision in the middle line near the pubis. Expose the bladder.

FIG. 808.—(*Squier and Heyd, Surg., Gyn. and Obst.*)
Counter-opening for drainage of bladder.

FIG. 809.—(*Squier and Heyd, Surg. Gyn. and Obst.*)
Accurate closure of the peritoneal cavity showing the two cigarette drains and separate stab-wound for drainage of bladder.

2. Excise the tumor and as much of the vesical wall as may be necessary.

3. Pull a loop of ileum down towards the bladder and divide it at two places (x–x, Fig. 810). The distance between the two lines of section (x–x) depends on the size of the defect in the bladder which it is desired to close.

4. The afferent and efferent loops of ileum (A and E, Figs. 810 and 811) are united by end-to-end anastomosis and at once returned to the abdominal cavity.

5. The isolated segment of ileum (S, Figs. 810 and 811) is split along its free border (*i.e.*, along the side opposite to the mesenteric attachment). A flap of tissue is thus obtained (S, Fig. 812) which is rectangular in shape, covered on one side by mucous membrane, on the other by peritoneum, and

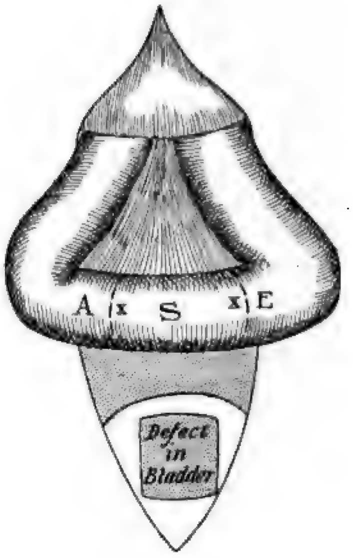


FIG. 810.

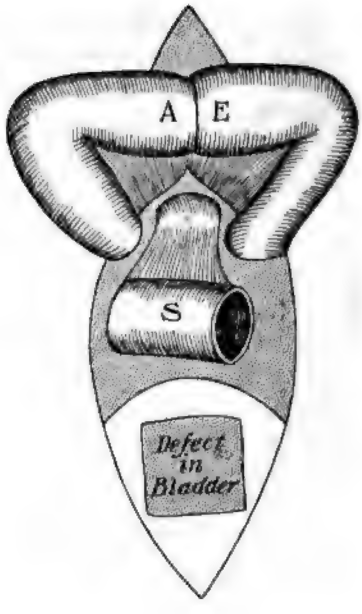


FIG. 811.

FIGS. 810 AND 811.—Rutkowski's operation.

contains non-striated muscular fibres. To the middle of its serous surface is attached the mesentery through which it is nourished.

6. The edges of the flap are attached to the edges of the defect in the bladder by a double layer of sutures. The mucous surface of the flap faces the interior of the bladder. The deep layer of sutures (catgut) includes the whole thickness of the bladder and of the gut walls except the surface of the mucous membrane. The superficial layer (silk) is applied after the Lembert method. Continuous sutures are used.

7. A catheter is passed into the bladder *per urethram* and is kept there.

8. The abdominal wound is closed.

Mikulicz has modified the above operation. After isolating a segment of ileum and uniting the afferent and efferent loops (Step 4), he closes, by suture,

one end of the isolated segment and sutures the other, or open end, to the abdominal wound near the bladder. The abdominal wound is closed. After a sufficient period of time has elapsed to demonstrate that the segment of ileum is sufficiently nourished, he proceeds to remove the vesical tumor and repair the bladder with the segment of ileum obtained at the first operation.

Complete Cystectomy.—Tuffier ("Revue de Chir.," April, 1898) reports a successful case of complete cystectomy in a man suffering from extensive epithelioma confined to the bladder. In his case the operation was complicated by a previous suprapubic cystotomy having been practised. The complication was overcome by packing the bladder with gauze and by dissecting the fistulous tract free from the parietes. Ample room for work was obtained by a combination of the transverse and vertical incisions recommended in cystotomy. The steps of the operation were, briefly, as follows: Exposure of the anterior surface of the bladder. Separation of the anterior and lateral surfaces from the peritoneum and adjacent structures. It is thus easy to isolate the neck of the bladder and the pedicles containing the inferior vesical vessels and the ureters. Clamp the vessels and ureters together and cut between the clamps and the bladder. Divide the neck of the bladder between clamps and cauterize the opened urethra. It may be well to make the division of the vesical neck with the cautery. With forceps or clamps pull the bladder into the abdominal wound and decorticate, *i.e.*, separate it from its peritoneal covering under traction. Tuffier succeeded in doing this without opening the peritoneal cavity. If the peritoneum is torn, the opening must be closed at once with sutures. Having removed the bladder, turn to the pedicles containing the vesical vessels and ureters. Isolate the ureters and tie the vessels. Pass a catheter into each ureter and fix it to the urethra with a stitch. Ligate the vessels in the urethral stump.

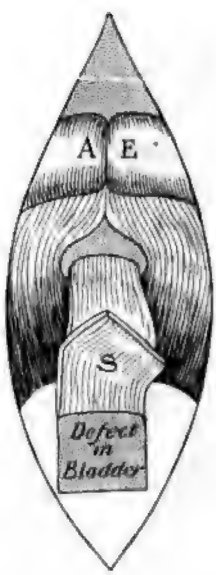


FIG. 812.—Rutkowski's operation.

In Tuffier's case he at once anastomosed the ureters to the rectum, but the union evidently gave way, as the patient developed a suprapubic fistula. If the patient is in poor condition, it is wise to bring the ureteral catheters out through the suprapubic wound and leave any attempts at anastomosis until later. After attending to hemostasis, pack the cavity with gauze and partially close the wound with sutures. Tuffier's classical case lived in comfort for seven months. In the female, Pawlik operated in two stages with an interval of about three weeks. His operation may be performed as follows:

First Stage.—Uretero-vaginal anastomosis. Catheterize the ureters. Incise the vagina over each ureter. Divide and bring the end of each ureter into the vagina. Split the lower end of each ureter for about ⅓ inch and suture the

edges of the split to the vaginal wound. Fix with stitches a catheter in each ureter.

Instead of practising any method of ureteral implantation, Frank Watson advises permanent nephrostomy.

Second Stage.—Excision of the bladder. Fill the bladder with an emulsion of iodoform. Through a suprapubic incision separate the bladder from its surroundings down to the urethra. Empty the bladder. Pack the suprapubic wound with gauze. Make an incision through the anterior wall of the vagina at a point opposite the internal urinary meatus, pull the isolated bladder through this incision, and divide it where it joins the urethra. Remove the bladder. Pass ureteral catheters through the urethra into the ureters. Denude and close by sutures the vaginal outlet, thus forming a urinary reservoir drained by the urethra.

F. S. Watson recommends nephrostomy as a preliminary to complete cystectomy.

Rovsing (German Surg. Assoc., 1907) advises the removal of the bladder as if it was a cystic tumor without opening it.

Step 1.—Fill the bladder with a mild antiseptic solution. Put the patient in Trendelenburg's posture. Expose the distended bladder through a curved transverse incision (convexity downwards), near the pubis.

Step 2.—Separate the vertex and sides of the bladder from their connections. While doing this doubly ligate and divide all strong bands of tissue containing vessels. If possible separate the posterior wall from its peritoneal covering. If the infiltrated bladder wall is firmly adherent to the peritoneum, open the belly cavity and remove the bladder with its peritoneal covering.

Step 3.—Expose, doubly ligate, and divide the ureters about ½ to ¾ inch from the bladder.

Step 4.—(*a*) In the female it is easy to free by blunt dissection the neck of the bladder and about ¾ inch of the urethra. Clamp and divide the urethra.

(*b*) In the male separate the base of the bladder and the prostate from the rectum. This leaves the bladder attached to the body by the membranous urethra alone. Doubly clamp and divide the urethra. Leave the distal clamp *in situ* for 24 hours to prevent bleeding from the cavernous tissue.

Step 5.—If the peritoneum has been opened, close it with sutures. Pack the cavity with gauze which is brought out through the middle of the wound. Unite the wounded recti muscles. Close the excess of wound. Apply dressings.

Step 6.—Expose both ureters through a 3- to 4-inch incision on each side running obliquely outwards and downwards from the edge of the erector spinæ muscles. The ureters can be palpated close to the pelvis of the kidney. Fix the ureters with a finger, and with another finger bluntly dissect them loose throughout their whole length and pull them out of the lumbar wounds. Close the lumbar wounds with sutures, leaving the ureters hanging loosely out of them. Pass a No. 12 catheter into each ureter to prevent its compression by the wound. Pull the exposed part of each ureter through the perforated finger of a rubber glove to protect the wound. Apply dressings. By the time the

lumbar wounds have healed the excess of ureter has become shrunken and necrosed, and may be removed. Rovsing has performed the above operation three times, twice successfully.

J. Verhoogen ("Journ. de Chir.," March, 1907; ref. "Zent. für Chir.," 1907, No. 32) recommends the following operation:

(1) Open the abdomen. Explore as to extent of disease, adhesions, etc.

(2) Expose the ureters where they cross the vessels at the pelvic brim.

(3) Anastomose the right ureter to the cæcum, the left to the sigmoid. Make the anastomoses valvular, like Witzel's gastrostomy.

(4) Excise the bladder, forming an anterior and posterior peritoneal flap.

(5) Drain through the vagina, or, in the male, through the perineum after removing the prostate.

(6) Close the abdominal wound entirely.

Operative removal of benign neoplasms gives good results; the extirpation of malignant growths occasionally does so.

Prostatotomy.—The principle at the base of all operations for the relief of the troubles arising from enlarged prostate is the provision of drainage for the most dependent portion of the bladder. Such drainage may be secured by suprapubic prostatotomy.

Expose and open the bladder by the vertical incision. Explore the bladder and recognize the nature of the prostatic obstruction. Introduce a tubular speculum (caisson or coffer-dam) and engage the prostate in its open end. The use of this is not essential. With gauze dry the surface of the tissues enclosed in the end of the speculum. Pass a thermocautery, heated to a red heat, through the speculum and burn a groove or gutter from the prostatic urethra to the vesical pouch behind the prostate. This provides drainage of the most dependent portion of the bladder. If the lateral lobes of the prostate obstruct the urethra, it is well to burn deep grooves or gutters in them also. Provide suprapubic drainage and partially close the wound. This operation is very similar in principle to the Bottini operation, but it is done under guidance of the eye.

Galvano-caustic Prostatotomy (Bottini's Operation).—The object of the Bottini operation is to make one or more furrows through the obstructing prostate, thus lowering the vesical orifice of the urethra and permitting efficient drainage of the bladder.

The favorite instrument for division of the prostate is Freudenberg's modification of Bottini's galvanocautery (Fig. 813). H. Young has devised an instrument in which various sized blades can be used ("Jour. Am. Med. Assoc.," Jan. 11, 1902).

Da Costa thus describes the operation: "The bladder should be emptied, irrigated, and distended with air, and the posterior urethra must be anesthetized by instillation of cocain or eucain. The current is tried to see how many seconds it requires to heat the blade sufficiently. The current is broken, the instrument is introduced, the cooling current is set in motion, and one assistant watches this and nothing else. Turn on the current. Wait the re-

mber of seconds for the blade to become red hot (twelve to fifteen turn the screw at the handle, and burn a groove in the prostate. A uld be burned towards the rectum, one to the side, and, if it is thought one to the opposite side. No groove should be burned towards the Then a groove has been burned, return the blade into its sheath, the current while doing so in order to keep the blade from adhering ue, and then shut off the current. After withdrawing the instrument ecessary to introduce and retain a catheter. The patient is confined y twenty-four hours, there is rarely bleeding or fever, and the results The scars contract and the gland atro-uring the period of healing a steel sound passed from time to time (Bangs)."

ood has devised a short cautery which ices through a perineal opening and so ie grave danger of urethral injury men- page 701.

e indirect treatment of prostatic hyper- W. White has strongly recommended and R. Harrison and Mears, vasec- ision or resection of the vasa deferentia). rations are too simple to require de-

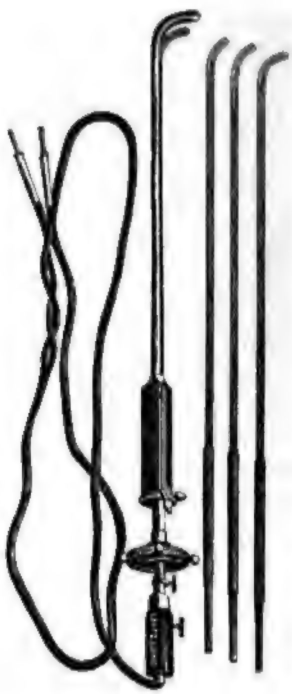


FIG. 813.—Cautery. (*De Costa.*)

ks on the Treatment of Prostatic Hy- —The patients are almost always aged and still more aged in physical condi- ortunately, until recently, operation has dered the last resort, hence the patients permitted to get into a very dreadful The operation required for cure is of severity, hence if the patient can be fair state of comfort and health by treatment, such treatment is the best. hygienic measures and the proper use theter fail to give relief, it is wrong to e; the patient must be given the option of radical treatment.

tion or orchidectomy is the least efficacious method of treatment, g a high rate of mortality and of induced insanity, it has been prac- carded. Vasectomy possesses any advantages which may pertain to 1 and is much less dangerous. It has no effect on fibrous and adeno- enlargement, but favorably influences congestive conditions. It be of use in cases of "prostatismus" where the symptoms of prostatic phy are present, but there is no residual urine. Wassiljew ("Central- hir.," 1903, No. 26) thinks the benefits derived are due to the resulting of the tone of the vesical sphincter.

main objects aimed at by operations on the prostate are (1) removal

of the cause of the obstruction, (2) lowering of the vesical mouth of the urethra so that the bladder may empty itself.

The most surgical means of attaining the above objects is by prostatectomy, either suprapubic or perineal. Both of these methods are good in suitable cases. Where the perineum is deep, or where the hypertrophy is mainly intravesical, the suprapubic route is the better. Most forms of hypertrophy can be removed by the perineal route, and this route gives the better drainage. Until recently perineal prostatectomy was the operation of choice with most surgeons in America, while in Britain the suprapubic route has long been the vogue. Whichever method is chosen, the operation is one of severity and ought not to be undertaken when renal disease is present. Prostatotomy, whether accomplished via the suprapubic route by means of a thermocautery or through the urethra, as in the Bottini operation, attains one of the objects of radical operation in that it lowers the vesical orifice of the urethra. The suprapubic method has the advantage of being done under the guidance of the eye, with inexpensive instruments, and of requiring no special manual training. The disadvantages are the necessary suprapubic cystotomy, and the fact that the resulting scar in the prostate is thicker and clumsier than that left by the galvanocautery. The Bottini operation has been thoroughly tested by many surgeons, notably by Horwitz and Willy Meyer, the latter having operated 71 times on 59 patients without any reference to the character of the lesion or the presence of renal or other disease. Out of the 59 cases 7 died, but the death was the direct consequence of the operation in but 3.

The author has seen one case in which, owing to some unsuspected flaw in the instrument used, the urethra was severely burned, and in part obliterated, while the prostate itself had escaped without being cauterized. The condition of the prostate was demonstrated during a subsequent suprapubic operation done by J. Block to establish drainage. The original operator was a surgeon of great experience in this class of work.

CHAPTER L

PERINEAL SECTION

PERINEAL CYSTOTOMY

Perineal cystotomy, or the boutonnière operation, is perhaps the simplest and safest method of opening and exploring the bladder. As a method of exploration it is defective in that it is difficult to reach all parts of the bladder with the finger, especially when the perineum is deep. Ocular inspection is also impossible. As a therapeutic agent it is of great value in providing drainage and giving rest, not merely to the bladder, but to the urethra; it also permits the removal of small calculi and neoplasms from the bladder. Perineal cystotomy is one of the steps in certain methods of perineal prostatectomy.

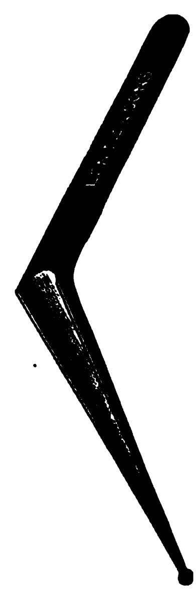


FIG. 814.—Teale's gorget.

Preparation of the Patient.—Thoroughly evacuate the large intestine by means of irrigation. Irrigate the bladder and partially fill it with warm water or boracic acid solution. Shave the perineum. Cleanse the perineum, scrotum, penis, and hypogastric region. Place the patient in the lithotomy position with the buttocks elevated and well over the edge of the table.

The Operation.—*Step* 1.—Pass a staff, provided with a median groove on its convex side, into the bladder. By holding the handle of the staff close to the hypogastrium force its curve against the perineum, which is thus made prominent. Intrust the staff to an assistant, who holds it steadily and accurately in place. The surgeon now sits down, facing the field of operation.

Step 2.—Protect the hand with a rubber glove and, *per rectum*, palpate the prostate, etc. Having done this, remove the glove. With the fingers of the left hand steady the skin of the perineum and make a median incision from a point posterior to the scroto-perineal junction to within one inch of the anus. Keeping strictly in the middle line, deepen the incision until the urethral bulb is exposed. Do not injure this structure. Pull the bulb forwards in the middle line and continue the dissection behind it until the staff can be felt in the membranous urethra. Open the urethra on the staff, and freely incise it from the bulb to the apex of the prostate.

Step 3.—Guided by the groove in the staff pass a curved grooved director or a Teale's gorget (Fig. 814) into the bladder. Remove the staff. Along the director or gorget push the finger into the bladder with a boring motion.

This forcibly dilates the prostatic urethra. With the finger explore for calculi, neoplasm, enlarged prostate, etc. If a small calculus is present, remove it with a lithotomy forceps or scoop. If a small, benign, pedunculated neoplasm presents, remove it with the finger or by crushing its pedicle with forceps. Be careful not to drag forcibly on the tumor. Sessile or large tumors are better attacked through a suprapubic incision.

Step 4.—Having finished the exploration or the active operation, introduce a drainage-tube approximately equal in size to the exploring finger. Watson's drainage-tube is excellent (Fig. 815). R. Harrison uses a large rubber catheter with a terminal as well as lateral eye. With one or two points of suture make the perineal wound hug the tube. Fix the tube in place with a safety-pin or tapes. Test the patency and efficiency of the drain by irrigating the bladder through it. The end of the tube should reach, but not penetrate far into, the bladder.

Return the patient to bed, the upper end of which ought to be elevated slightly. The mattress ought to be firm and not sag under the patient's weight, otherwise drainage will be poor. The perineum is covered by dressings kept in place by a T-bandage through which the drainage-tube emerges. It is easy to attach to the drain a long rubber tube which conducts the urine to any convenient receptacle. After two or three days the drainage-tube must be changed. The time during which drainage must be kept up varies according to the operation performed. After a simple lithotomy the tube should be removed in two or three days and the wound allowed to heal. In cases of cystitis or posterior urethritis drainage ought to be kept up until the tissues get into a healthy condition.

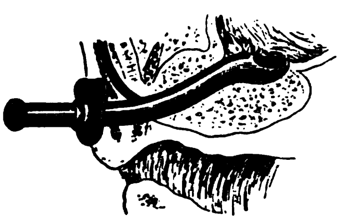


FIG. 815.—Watson's drain. (*Stewart.*)

If in Step 3 forcible digital dilatation fails to give a sufficiency of room, median prostatotomy may be performed. Using the finger in the prostatic urethra as a guide, introduce a probe-pointed knife and with it divide the prostate in the middle line posteriorly. Bleeding may be stopped by pressure from a snugly fitting Watson's drain or by packing the wound with gauze around a stiff gum-elastic drainage-tube. Prostatotomy performed as above is an integral part of some of the procedures for the removal of enlarged prostatic lobes.

As the perineal operations for the removal of vesical calculi (lateral lithotomy, Wood's operation, etc.) are thoroughly described in every text-book on general surgery ("American Text-book"; Moullin; Rose and Carless; Parkes, etc.), they will not be treated of here. The same is true of the operation of litholapaxy.

PERINEAL PROSTATECTOMY

A very large number of incisions have been described by which the prostate may be exposed in the perineum. When these are analyzed they resolve

themselves into two, each of which may be modified during the operation according to the dictates of common sense.

Method A: Median Incision.—The earlier steps of this operation are identical with those of median perineal cystotomy. When the membranous urethra is opened and the prostatic urethra dilated, pass into the bladder a suitable tractor, and with it pull the prostate downwards into the wound.

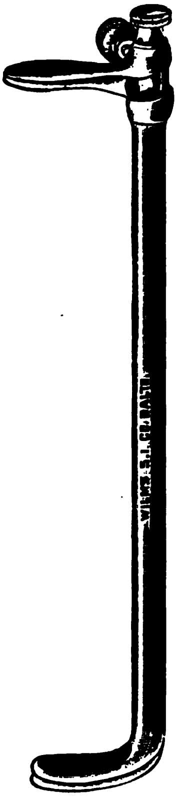


FIG. 816.

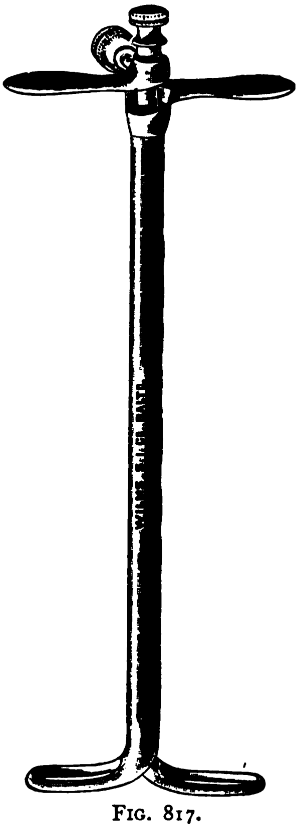


FIG. 817.

FIGS. 816 AND 817.—Young's prostatic tractor. (*Young.*)

Several efficient tractors have been devised for this purpose; the best known are Parker Syms', provided with a dilatable rubber bulb; Young's (Figs. 816, 817), having separable metal blades, and A. H. Ferguson's. In the absence of a special instrument any good stout metal sound answers the purpose.

With scissors or knife incise the fibrous sheath of the prostate; insinuate the finger between the sheath and the gland and enucleate the latter. Sometimes the prostate comes away in one piece, sometimes in two or more fragments. Most surgeons begin the enulceation in the left lobe; this is a mere matter of convenience. "Usually, but not always, the floor of the prostatic urethra is divided when the middle portion is being taken out; but the author has had all his specimens examined by the microscope, and it has been shown

45

that no mucous membrane has been taken away" (except in one case). (Parker Syms, "Brit, Med. Jour.," Nov. 8, 1902.) Drain the bladder by a perineal tube (No. 36 Fr.) fastened to the upper part of the wound. Pack the wound cavity firmly with iodoform gauze. Attach a rubber tube to the drain so as to conduct the urine to a suitable receptacle. Wash out the bladder frequently through the drain. Change the gauze pack after the lapse of twenty-four hours, lessening the amount of gauze used. Encourage the patient to move about in bed and to sit up at the earliest possible moment. This is important. Remove the drain in about one week. After the drain is removed wash out the bladder at intervals by means of a catheter. Occasionally introduce a sound to maintain the urethra patent. In operating in much the same manner as above described, H. Young divides the prostatic capsule external to the location of the seminal ducts, and believes he is able to remove a sufficiency of the gland without destroying these structures. That portion of the prostate subjacent to the ejaculatory ducts is not involved in the hypertrophic process and hence can be safely left.

Another method is as follows: Expose and open the membranous urethra as above; guided by the finger passed through the prostatic urethra divide the prostate posteriorly in the middle line with a probe-pointed knife (median prostatotomy). Seize the edge of the divided capsule in forceps, and with the finger separate the capsule from the gland and shell out the latter *en masse* or in pieces. As the enucleation proceeds, it is well to make traction on the lobes, which are being removed, by means of claw-like sharp retractors. George Gray, after dividing the prostate as above, pushes his finger into the bladder, insinuates it between the prostate and the vesical mucosa and then shells out the enlarged lobes from above downwards. Through the urethral wound it is easy to shell out the middle lobe if it is enlarged, and to remove any vesical calculi which may be present. In cases where enucleation with the finger is difficult some surgeons extirpate by *morcellement*, cutting the gland away piecemeal with scissors or rongeur forceps; when this is done, it is advised to begin the extirpation remote from, and work towards, the urethra.

Method B: Transverse Incision.—Zuckerkandl was probably the first to advocate this method of exposing the prostate. The whole operation has been well systematized by Albarran. Very many operators have devised various modifications in details, using incisions of divers shapes, **H, Y, Y,** etc., to increase the exposure of the prostate. Practically, any one of these cuts give as good results as any other.

Prepare the patient as already described and place him in the lithotomy position with the pelvis well elevated. This posture, a combination of the Trendelenburg and lithotomy positions, is of very great service, being almost essential. Introduce a sound or staff into the bladder and entrust its handle to an assistant.

Step 1.—One fingerbreadth in front of the anus make a slightly curved (concavity posterior) transverse incision through the skin and subcutaneous tissue, from one ischial tuberosity to the other.

Step 2.—Guided by the sound in the urethra expose its membranous portion and bulb. Catch the tissues on each side of the bulb with volsellum forceps and so pull the bulb upwards out of the way and at the same time steady the perineum. Do *not* open the urethra. Introduce a finger of the left hand (protected by a rubber glove) into the rectum, and with the right hand separate the rectum from its anterior connections—*i.e.*, from the prostate. This may be done by blunt dissection, aided by an occasional cut with sicssors. If the surgeon keeps close to the prostate, this step is easy. The finger in the rectum saves injury to that structure. Introduce a broad, flat, long-bladed retractor into the wound and pull the rectum and posterior surface of the wound backwards, exactly as the vagina is retracted in operations on the cervix uteri.

Step 3.—Make the assistant turn the beak of the sound backwards so as to lie behind the middle lobe of the prostate and pull it down into the wound as much as possible. Instead of a sound Young's (Figs. 816 and 817) or Ferguson's prostatic tractor may be used. The prostate now lies exposed.

Step 4.—Split the prostatic capsule by a transverse or vertical incision as may be convenient. If it is desired to save that portion of prostate corresponding to the urethral floor, make a longitudinal cut on each side through the capsule. Seize the edges of the wound in the capsule with forceps and with the finger insinuated beneath the capsule enucleate the gland. As the enucleation proceeds pull on the part being removed with claw-shaped retractors. If the urethra is accidentally torn, the middle lobe when enlarged can be easily reached and enucleated with the finger. The accident to the urethra does not seem to be of much moment. If the urethra is not opened and a projecting middle lobe is present, it can be reached and removed with the finger through the prostatic wound.

Step 5.—Partially close the deep wound with sutures. Introduce a drain into the bladder and firmly pack the wound with iodoform gauze.

It will be seen that, except in the matter of exposure, the operation by transverse incision is almost identical with that by median. Undoubtedly by the transverse method a much better exposure of the field of operation is obtained, at the expense of a little more trauma, but most of the actual work is done by the finger unguided by the eye, hence the improved exposure is not of so much value as might appear at first glance.

All the operations here described are carried out inside the capsule; extracapsular operations have been devised and described, but they occasion so much shock and hemorrhage that they are unsuited to the extirpation of benign neoplasms. While none of the methods described can be truly named complete prostatectomies, yet they approach so nearly to completeness that they may be termed so for the sake of convenience and to distinguish them from the next class of operations, which are frankly incomplete. Rydygier, Riedel, and others frequently expose the prostate by the transverse incision and content themselves with excising portions of the lateral lobes, opening neither the urethra nor the bladder. The result of taking away such portions of the prostate

is that pressure is removed from the prostatic urethra, and as the wounds heal and contract, the urethral lumen is widened. The method is less severe than the more complete operations and has given good results even in cases in which the middle lobe has been enlarged. Of course, the operation is meant primarily for cases of hypertrophy of the lateral lobes and it has a distinct field of usefulness.

Radical Prostatectomy for Cancer.—Young has described a method of removing the prostate for cancer ("Johns Hopkins Bulletin," Oct., 1905; "Annals Surg.," Dec., 1909) which he carried out in six cases. One of the patients was alive and well four and a half years and another six months after the operation. The operation is only suited to cases in which the disease is well limited to the prostate or at least does not extend more than a short distance beneath the trigone.

The Operation.—Steps 1, 2 and 3.—Place the patient in the exaggerated lithotomy position. Expose the membranous urethra and prostate by an inverted V-incision. Proceed as in prostatectomy by the transverse incision (Method B, Steps 1, 2, 3, p. 706) until the prostatic tractor is put in place and the posterior surface of the prostate has been exposed, largely by blunt dissection. If there is any doubt as to diagnosis, incise the capsule and remove a segment of gland for immediate microscopic examination.

Step 4.—Free the lateral adhesions of the prostate and also the seminal vesicles as much as possible by blunt dissection. Divide the membranous urethra in front of the tractor.

Step 5.—Depress the handle of the tractor markedly and divide the puboprostatic ligaments close to the prostate after pushing away the anterior plexus of veins. Hemorrhage must be controlled by clamps and by a gauze pack held tightly against the posterior surface of the pubes and the triangular ligament by means of a retractor. At this time the seminal vesicles may be further freed.

Step 6.—Pull the prostate as far as possible out of the wound, thus exposing the anterior wall of the bladder. Open the bladder by a transverse incision close to its junction with the prostate. Enlarge the incision until the trigone is well exposed. (Fig. 818.) With a scalpel continue the transverse cut in the bladder across the trigone, leaving the upper angles of the trigone intact and the ureters uninjured. By blunt dissection through the wound in the bladder complete the exposure of the seminal vesicles, pick up the vasa deferentia and divide them as high as possible. Remember that the vasa deferentia pass around the lower end of the ureters which must not be injured.

Step 7.—Separate the deep attachments of the seminal vesicles, controlling the resulting bleeding by clamps and ligatures. Remove the prostate, seminal vesicles, and about 5 cm. of the vasa deferentia in one piece.

Step 8.—Pull the anterior wall of the bladder down and form an anastomosis between the anterior part of the bladder wound and the divided membranous urethra, using catgut for sutures. (Fig. 819.) Close the rest of the

FIG. 818.—Prostatectomy for cancer. (*Young, Annals of Surg.*)

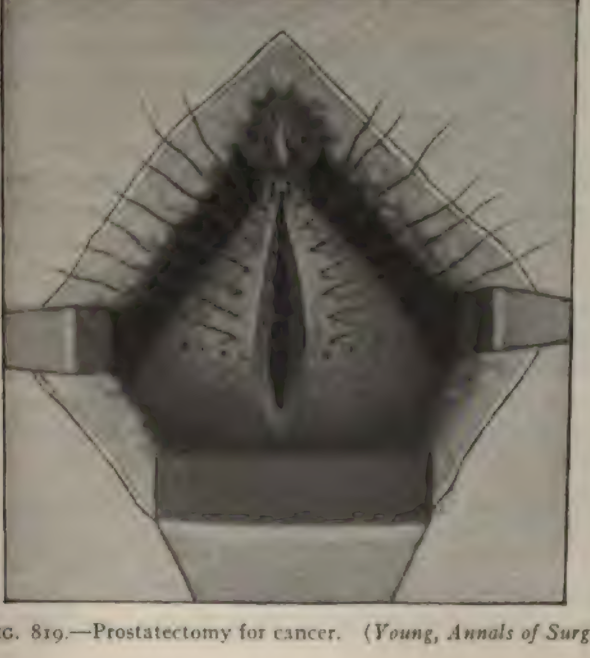


FIG. 819.—Prostatectomy for cancer. (*Young, Annals of Surg.*)

vesical wound by catgut sutures. Introduce through the penis a retention catheter.

Step 9.—Approximate the levator ani muscles with catgut sutures. Partially close the skin wound after providing for drainage.

Diverticula of Urinary Bladder.—The method of operating varies with the site of the diverticulum.

1. The diverticulum is situated on the anterior surface or the side of the bladder. Expose the bladder through a transverse or a median incision. Do *not* open the peritoneum but push it aside until the diverticulum is exposed. Excise the diverticulum and treat the wound in the bladder as described on p. 681.

2. The diverticulum is on the dome of the bladder and cannot be exposed extra-peritoneally. Open the abdomen. Protect the peritoneal cavity thoroughly with pads. Excise the diverticulum. Close the vesical wound and provide for drainage as described on p. 690. As the diverticulum is always the seat of severe infection it might possibly be better to operate in two stages: (*a*) bringing the diverticulum and part of the vesical wall into the abdominal wound and suturing the parietal peritoneum to the bladder around the diverticulum; (*b*) after the peritoneum has become protected by adhesion, excising the diverticulum and closing the vesical wound.

3. The diverticulum arises from the posterior wall of the bladder and lies between the bladder and rectum.

Graser (Kreuter, Zent. f. Chir., Nov. 8, 1913, p. 1740) operates as follows:

Step 1.—Drain and explore the bladder suprapubically. With a sound in the diverticulum and a finger in the rectum the size and location of the lesion is easily defined.

Step 2.—Place the patient in the combined Trendelenburg and lithotomy position. Make a curved transverse incision (concavity posterior) from one ischial tuberosity to the other. Guided by a sound in the urethra, expose the membranous urethra and the prostate. A finger in the rectum is an essential aid in orientation. Separate the rectum from the prostate and bladder until the diverticulum is reached. Because of past and present inflammation the diverticulum is firmly adherent to its surroundings. Remove the finger from the rectum and change gloves. Open the diverticulum. With a finger in the diverticulum as a guide, separate it from its surroundings by blunt and sharp dissection, pushing the peritoneum out of the way.

Step 3.—Excise the diverticulum and invert its stump into the bladder by means of stitches, being careful not to injure or occlude the ureter.

Step 4.—Thoroughly drain the perineal wound. Provide for suprapubic drainage.

INFRAPUBIC PROSTATOTOMY AND CYSTOTOMY

The prostate and lower part of the bladder may be exposed immediately under the pubic arch. This route avoids the neighborhood of the anus, with its ever present infection, while it gives more direct access to the prostate and

better drainage than does the suprapubic route. If the patient is feeble, the operation may be done in two sittings, the first consisting of the exposure of the prostate, the second of the prostatotomy or prostatectomy. (L. Heusner, "Centralblatt f. Chir.," 1904, p. 217.)

Step 1.—Make a curved incision through the skin along the lower margin of the pubis and its descending rami.

Step 2.—Divide the insertion of the suspensory ligament of the penis, the corpora cavernosa; the ischio-cavernosus muscle, the triangular ligament, and part of the insertion of the adductor muscles. With a chisel or rongeur forceps cut away about half of the symphysis pubis and of the descending rami. Separate the prostate from the posterior surface of the pubes. When this is done, it is easy to pull the prostate downwards and expose its whole anterior surface. Bleeding from the plexus of veins anterior to the prostate is liable to be considerable. If this cannot be sufficiently controlled to permit of further progress, or if, as in Heusner's case, the patient is too weak, it is easy to pack the wound and resume the operation after the lapse of a few days.

Step 3.—Pass a sound into the bladder *per urethram.* Using the sound as a guide, split the prostatic urethra through its whole extent along its anterior or ventral surface. This exposes the prostate exactly as in a postmortem.

Step 4.—Remove all obstructing lobes exactly as is done when other methods of exposure are employed. If it is desired to open the bladder instead of the prostate, this is easily accomplished by the removal of more bone from the pubis. The operation is, however, much more suitable for prostatic than for vesicular disease.

Step 5.—Close the wound in the prostate with a few catgut sutures. Provide for drainage. Close the skin-wound.

Vesiculotomy.—Vesiculectomy has been performed a number of times but the results have not been encouraging and the operation will not be described here. The chronicity of many urethral infections is often due to involvement of the seminal vesicles, and for the treatment of these lesions Eugene Fuller has advised emptying the vesicles by stripping them with the finger introduced *per rectum.* This treatment must necessarily be kept up for months. The same surgeon, in inveterate cases, advises drainage of the vesicles by means of vesiculotomy. In view of the importance of obscure infections in the etiology of the so-called rheumatisms, etc., the subject of vesiculotomy has become one of distinct moment, though the operation can scarcely be expected to become as fashionable as has the removal of adenoids and of more or less innocent tonsils in the treatment of rheumatism.

Fuller's Vesiculotomy (N. Y. Med. Record, Oct. 30, 1909).—Thoroughly empty the large bowel by means of purgatives and enemata. Place the patient in the knee chest position, the hips being well flexed and abducted, the knees being flexed. The services of two attendants are requisite to keep the patient in correct position.

Step 1.—Beginning at a point near the base of the coccyx, and just inside the body of the ischium, make an incision past the *tuber ischii* to end at a point

about $\frac{3}{4}$ inch external and about $\frac{3}{4}$ inch anterior to the anterior border of the anus. Make a similar incision on the opposite side. Unite these two incisions by a transverse cut crossing the perineum (Fig. 820).

Step 2.—Through the lateral incisions divide a few of the lower fibres of the gluteus maximus muscles and penetrate the fat of the ischio-rectal spaces. Through the transverse cut divide the anterior layer of the deep fascia but carefully avoid injuring the anal sphincter.

Step 3.—With the forefinger of the left hand in the rectum as a guide separate the rectum from the prostate and seminal vesicles by means of blunt dissection with the right forefinger. "All the while the right forefinger tip is peeling the rectal wall off from the lower structures, the left forefinger tip maintains its position in the rectum, guiding, as it were, the lower finger in its work and preventing it from directing the dissection pressure against the rectal wall, thus endangering perforation. As the rectal wall only separates these two fingers, it is easy to appreciate the distinctness with which the left finger tip can feel the right as it accomplishes its work of separation. The rectal wall having been thus separated from the seminal vesicles the left forefinger is withdrawn from the rectum while the tip of the right forefinger is maintained in the dissection and made to press gently but firmly over the apex of the right seminal vesicle. A long, grooved director is next passed by the free left hand along and under the right forefinger until the end of the instrument reaches the apex of the right seminal vesicle and lies just under the right finger tip. The left hand then holds the director firmly in that position, while the right forefinger is withdrawn. The right hand then take a scalpel, the blade of which is passed along the groove of the director until the point of the knife enters the apex of the seminal vesicle. After the point has so entered, the shaft of the scalpel is lowered and a free cut of about $1\frac{1}{4}$ to $1\frac{1}{2}$ inches is made with the belly of the blade along the course of the seminal vesicle, freely laying open the cavity of the organ. This cut is made with the belly of the blade rather than with the point of the scalpel, for if made with the point the incision might be accidentally too deep, the floor of the bladder being opened. The incision so made is then divulsed with the finger tip, thus widely opening the sac cavity. By an exactly similar procedure the cavity of the left seminal vesicle is next opened. The cavities thus opened can be exposed with the finger tip and, if found filled with granulation tissue, currettage can be employed. Oftentimes the finger nail may be most efficient for this purpose, although, in advanced instances, a sharp steel instrument may be necessary. Seminal vesiculotomy is not a bloody operation, no vessel, as a rule, of sufficient size to require a ligature being encountered. The cavities of the seminal vesicles so opened are each separately packed with gauze, the end of each packing

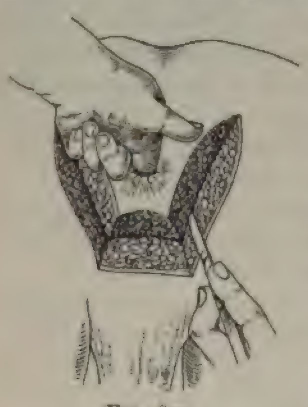


FIG. 820.

being left protruding from the external wound. Two soft rubber drainage tubes are then placed between the gauze packing and the rectal wall. The lateral edges of the incision are next brought into natural apposition by sutures, the transverse portion of the cut only being left open for the ends of the drainage tubes and the gauze packing. In the after-treatment no irrigation into the ends of the tubes is advisable. The gauze is removed at the end of the fifth day; the drainage tubes at the end of the ninth or tenth day. The bowels are moved daily, to guard against rectal fecal distention. In some cases urinary retention follows operation; consequently, the surgeon should be prepared to have a soft catheter passed if necessary. There is generally little systemic disturbance after this operation. A bulky gauze dressing held in position by a T bandage is the form of external dressing employed. The operation generally necessitates a stay in a hospital of three weeks, the first two weeks being in bed."

CHAPTER LI

URETHRAL STRICTURE

Meatotomy.—As a preliminary to the introduction of urethral sounds it is often necessary to enlarge the meatus.

Introduce a probe-pointed knife into the urethra for a distance of about 3/4 inch, *i.e.*, to a point immediately behind the meatal narrowing. Cut in the middle line below, but do not cut completely through to the external surface, otherwise a hypospadias will be produced. The after-treatment consists in keeping the wound open by passing a sound or a glass rod at frequent intervals.

Internal Urethrotomy.—*Preparation of Patient.*—Sometimes it is wise to prepare the patient by administering urotropin or its equivalent for a day or two before operation. Immediately before operating wash the penis and especially the glans with soap and water, cover the thighs and abdomen with sterile towels, irrigate the urethra (and if possible, the bladder) with a mild antiseptic solution or with warm salt solution. Inject into the urethra a drachm or two of sterile olive oil and immediately proceed to operate.

There are two types of operation: (A) in which the stricture is divided from before backwards; (B) in which the division is from behind forwards. The latter method presupposes that the stricture is not a narrow one or that it has been already dilated sufficiently to admit the passage of the urethrotome. Of the two types of operation there are many varieties, but only the typical procedures will be described here. The number and varieties, of urethrotomes are legion. Their description would take up much space and serve no useful purpose.

A. *Division of the Stricture from Before Backwards.*—Prepare the patient as above. Determine, if possible, the site and extent of the stricture or strictures by means of a *bougie a boule*. Introduce through the stricture a soft filiform bougie the proximal end of which is fitted with a screw. Screw the distal end of a Maisonneuve urethrotome (Fig. 821) to the filiform guide. Push the urethrotome along the urethra, the knife blade being in contact with the middle of the roof of the urethra. The knife blade being blunt at its apex cannot cut the normal urethra, but its distal edge being sharp cuts the stricture when it comes against it. Having divided one stricture, remove the urethrotome and explore the whole urethra so as to find if other stenoses are present. The urethra should now admit a full-sized sound.

B. *Otis' Operation: Division of the Stricture from Behind Forwards.*—Preparation and exploration of the urethra as already described. Introduce an Otis' urethrotome (Fig. 822) through the stricture. By means of the screw at the proximal end separate the blades of the instrument until the tissues of

the stricture are put on the stretch but not torn. Up to this time a knife blade lies concealed at the distal end of the urethrotome. By using the proper mechanism, make the knife blade protrude and cut through the stricture in the middle line above. Sheath the knife blade again. Complete the dilatation of the stricture by separating the blades of the urethrotome until the urethra is large enough to admit a full-sized sound. Remove the urethrotome. Explore for the presence of other strictures.

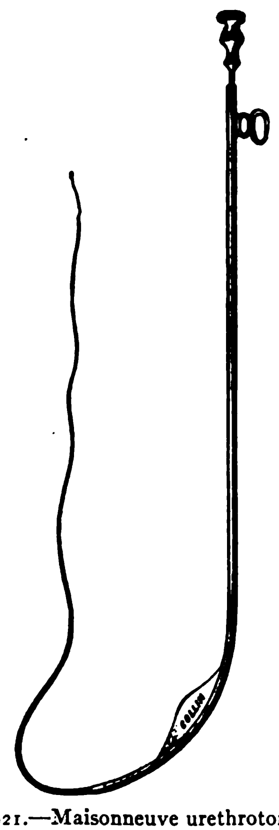


FIG. 821.—Maisonneuve urethrotome.

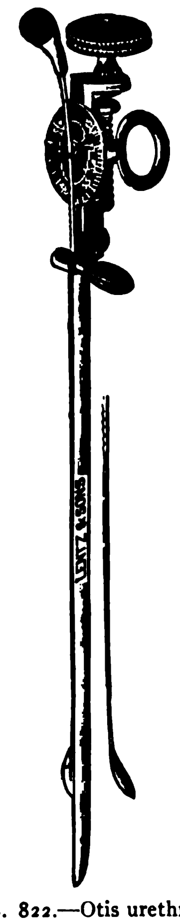


FIG. 822.—Otis urethrotome.

Complications and Dangers of Internal Urethrotomy.—1. *Hemorrhage.* By cutting in the middle line above, the least vascular region is incised. The stricture itself is sclerosed, non-vascular fibrous tissue, hence severe bleeding is not common. When serious bleeding arises it may be controlled by the passage of a full-sized catheter, and if necessary by exercising pressure from the outside on the urethra which is now supported by the catheter.

2. *Urethral Fever.*—This is usually a form of septic intoxication due to the absorption through the urethrotomy wound of septic products already

existing in the urethra or being discharged with the urine. Septicemia or pyemia are rare. *Methods of avoiding urethral fever:* (*a*) Preliminary exhibition of substances (*e.g.*, urotropin) calculated to improve the condition of the urine. (*b*) Rigid asepsis. (*c*) König advises to irrigate the bladder with a mild antiseptic solution as soon as the operation is completed and to leave in the bladder a few ounces of the solution. This dilutes and favorably affects the urine so that noxious substances are not absorbed from it when it is next voided.

Irrigation of the urethra during convalescence is rarely necessary.

After-treatment.—The patient ought to be kept in bed for a few days. If there is retention of urine a soft rubber catheter must be passed. Catheterization may often be avoided by applying moist heat to the perineum and hypogastrium, or by placing the patient in a hot bath with instructions to urinate in the water, if he can.

After a lapse of five to seven days pass a full-sized sound into the bladder. Before this can be done successfully it may be necessary to pass a number of smaller instruments of increasing size. Repeat the passage of sounds at intervals of two or three days. The daily passage of sounds irritates and is useless. The interval is to be gradually increased until a cure or practical cure is obtained.

External Urethrotomy.—Prepare the patient as for internal urethrotomy. In addition scrub and shave the perineum. Clean the scrotum and the adjacent portions of the buttocks and thighs. Explore the urethra and locate the stricture. Put the patient in the lithotomy position.

FIG. 823.—Syme's staff.

A. *Operation with a Guide.*—Various instruments may be used as guides. The best is probably the Syme's staff (Fig. 823). Filiform whalebone bougies serve the purpose well and are more commonly obtainable.

Step 1.—Pass the guide into the bladder. If Syme's instrument is used the thin portion passes through the stricture, the thick portion serves as a guide to the urethra on the meatal side of the stricture. If the whalebone filiform is used, pass alongside it or looped on it (like Gouley's sounds) a large metal sound down to the face of the stricture. Let an assistant hold the sound steadily in the middle line of the body and make its point press towards the skin of the perineum. Retract the scrotum upwards.

Step 2.—Palpate the perineum and feel the point of the sound. In the middle line make an incision down to the point of the sound. This opens the urethra immediately anterior to the stricture. Retract the edges of the urethral wound with sharp hooks, fine volsella, or with a couple of fine sutures

introduced for the purpose. Withdraw the metal sound. If Syme's guide is used leave it *in situ*.

Step 3.—If possible pass a fine grooved director along the guide and with a knife split the stricture completely. If it is impossible to introduce a grooved director cut down upon the guide from in front backwards until the whole stricture is divided. It is convenient at this stage to pass through the perineal wound a probe-pointed Teale's gorget (Fig. 824) into the urethra posterior to the stricture. The gorget acts as a guide to the full-sized sound or catheter which must now be passed through the urethra into the bladder. The use of the gorget is not necessary.

There are many modifications of the above operation, most of them requiring special instruments. For a description of such see treatises on genito-urinary surgery. The operation as described has served the author well.

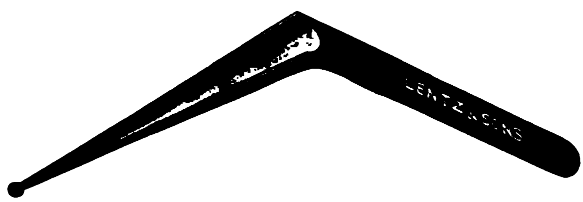


FIG. 824.—Teale's gorget.

B. *Operation Without a Guide.*—Prepare as described above.

Step 1.—Pass a metal sound down to the face of the stricture. Have it held by an assistant accurately and steadily in the middle line.

Step 2.—Incise the perineum, expose the sound, and retract the edges of the urethral wound as in the preceding operation. Remove the sound.

Step 3.—Examine carefully the face of the stricture with the eye and a fine probe for an opening through it. Remember that the opening may be in any position on the face of the stricture. The search may be aided by making a little pressure on the hypogastrium, and so forcing some urine along the urethra and out through the stricture, where its point of emergence should be noted. If it is possible to find the passage through the stricture and to introduce a probe the operation becomes identical with that in which a guide is used. If the introduction of a probe is impossible proceed as follows:

Incise the stricture longitudinally exactly in the middle line until the healthy urethra is reached posterior to the stricture. If this is not promptly accomplished, do *not* waste time and lacerate the tissues by making more incisions in the stricture tissues, but boldly endeavor to incise the urethra posterior to the stricture, always cutting in the middle line. When the urethra is opened at this point it is easy to cut through the stricture and pass a sound from the meatus past the perineal wound into the bladder. If the posterior urethra is not easily found during the above procedure do *not* spend much time looking for it, as such a search may do much damage. Open the bladder above the pubis and pass a sound through the bladder to the perineum (retrograde cathe-

terization). The point of this sound acts as a guide and makes incision of the urethra easy. The value of abstention from much burrowing in the perineum and of retrograde catheterization is insisted on, as the author has seen much damage result from the former and no harm from the latter procedure.

After-treatment.—Immediately after the operation irrigate the bladder. Stop all hemorrhage. Two methods of attending to urination are now possible:

(*a*) Apply a gauze pad to the perineal wound and permit the urine to escape either through the meatus or through the perineum, as it pleases. In one of the author's cases hardly a drop of urine escaped through the wound.

(*b*) Introduce a catheter (Jacob's self-retaining catheter is best) through the wound into the bladder and keep it there. It is easy to connect the catheter to a long tube and so drain the urine into some convenient receptacle.

Keep the perineal wound clean and frequently change the dressings. Some simple antiseptic ointment applied to the surrounding skin gives comfort and lessens scalding. After the lapse of five to eight days pass a sound through the meatus into the bladder. This is usually difficult. The writer has more than once found a spur in the depth of the perineal wound which rendered the passage of the sound impossible. Division of the spur was all that was necessary. The spur itself was undoubtedly the result of insufficient division of the stricture at the primary operation.

Repeat the passage of the sounds at constantly increasing intervals until a cure is effected. The perineal wound heals rapidly unless some strictures exist in the urethra anterior to it.

Urethrectomy: Excision of Stricture.—Complete urethrectomy is comparatively rarely indicated; it means excision of the whole *circumference* of the urethra. Incomplete urethrectomy is the usual operation; in it a portion of the dorsal wall of the urethra is preserved. The preservation of even a small strand of dorsal wall is of much importance, as it aids marvelously in securing apposition and acts as a guide in catheterization.

Perineal Urethrectomy.—*Step* 1.—Prepare the patient and open the urethra as in external urethrotomy.

Step 2.—If not already done, pass a sound or probe through the stricture. With forceps, knife, and scissors carefully and thoroughly remove every particle of the contracted and deforming scar tissue from the under and lateral side of the urethra, but preserve, if at all possible, a portion of the upper wall of the urethra. It is necessary to remove all the diseased tissue.

Step 3.—*Restoration of the Urethra.*—(*a*) Introduce through the penis to the bladder a retention catheter. Make an end-to-end union over the catheter of the divided urethra by fine, interrupted catgut sutures which do *not* penetrate the mucosa. To avoid stenosis it is necessary to incise longitudinally the floor of each segment to be united and convert the longitudinal into transverse wounds when suturing (Fig. 825, AA′, BB′). Be sure that each stitch has a firm hold. Either close the superficial perineal wound with sutures or permit it to heal by granulation.

(*b*) Hartmann usually introduces a retention catheter and over it closes

the wound with fine catgut sutures which do *not* penetrate the mucosa, but grasp all the perineal tissues except the skin. The skin wound he leaves open (Fig. 826).

Methods *a* and *b* are only useful when the separation of the two segments of urethra is not more than about 1½ inches (3 to 4 centimeters).

(*c*) When the urethral defect is very great, treat as after external urethrotomy. When all the diseased tissue has been excised the wound heals readily and rapidly, leaving a scar which is much softer and less liable to contract disastrously than if diseased tissue had been left (Hartmann).

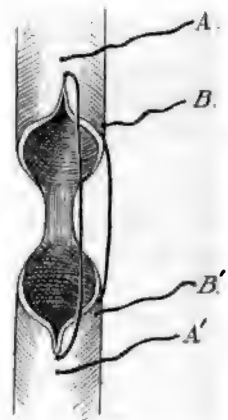


FIG. 825.—Restoration of urethra after urethrectomy.

After-treatment.—Remove the retention catheter on the eighth day. On the twelfth day begin passing sounds.

Russell's operation (R. Hamilton Russell, Brit. J. Surg., II, p. 375) promises to supersede all others. The male urethra can be slit up from the membranous portion to the meatus (the scrotum being split at the same time) and healing will take place without stricture provided that efficient perineal drainage of the bladder is secured during healing. The urethra under the above circumstances is changed from a tube of mucosa into a ribbon of mucosa and if left alone, its edges flanked on either side by raw tissues which tend to fall together and cohere, will, when this has taken place, be of necessity reconverted into a tube.

Step 1.—Place the patient in the extreme lithotomy position with the pelvis well raised. Make a Λ-incision having its apex at the central point of the perineum and open the ischio-rectal fossa on each side. Detach the external anal sphincter from the bulbo-cavernous muscle at the central tendon. Retract the sphincter backwards with a bifid retractor. Pull forwards the bulb of the urethra and the transversus perinei muscles thus exposing the membranous urethra and the apex of the prostate exactly as in perineal prostatectomy. Open the membranous urethra longitudinally and introduce a silk thread tractor into each side of the wound. Split the urethra forwards to the stricture.

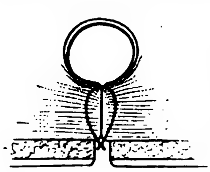


FIG. 826.—Suture of urethra.

Step 2.—Pass a guide or sound through the meatus to the face of the stricture and on it open the urethra longitudinally in front of the stricture, through a median cut which meets the apex of the first incision. Introduce silk tractors into the sides of this urethral wound and slit the urethra back to the stricture. The stricture now lies exposed, with an inch or two of split open urethra both behind and in front of it.

Step 3.—Excise the stricture along with the surrounding extra-urethral masses of scar tissue. This must be done thoroughly, but no more healthy mucosa sacrificed than is absolutely necessary. Mobilize the divided ends of the urethra by undercutting and unite them by five sutures of fine catgut.

Step 4.—Pass a catheter through the perineal wound into the bladder and anchor it with sutures. Close the lateral perineal wounds with deep silkworm-gut stitches. Do not place any sutures in the perineum in front of the catheter. After about one week the catheter may be removed and the perineal wound permitted to heal. Several weeks after healing has taken place pass full sized sounds. The occasional subsequent passage of a sound is an advisable precaution.

In a case in which "a very bad stricture in the bulbous urethra was complicated by multiple strictures in the penile portion, I slit up the urethra from the membranous portion to within an inch of the meatus, dividing, of course, the scrotum. The stricture of the bulb was excised, and the penile strictures treated plastically. No special sutures were put into the urethra other than those at the seat of excision; only in the penile portion the lateral margins of the urethra were caught up and approximated by inclusion in the skin sutures. The skin and scrotum were sutured, and healing took place uneventfully throughout. A full-sized instrument was easily passed for the first time five weeks after the operation" (Russell).

Penile Urethrectomy.—Apply an elastic constrictor to the root of the penis.

Step 1.—Make a longitudinal median incision to expose the stricture. Excise the *whole* cicatricial node, even, when requisite, removing part of the corpora cavernosa.

Step 2.—Suture the urethra with fine catgut sutures which do not penetrate the mucosa. Suture the cavernous and spongy bodies according to necessity. Remove the elastic constrictor so as to observe and control hemorrhage. Close the skin wound.

Step 3.—Open the perineal urethra and through this wound introduce a self-retaining catheter to keep the penile urethra from being irritated by the passage of urine.

Remarks.—Urethrectomy gives better results than external urethrotomy, but it rarely results in a radical cure. Subsequent passage of sounds remains necessary in most cases.

R. Mühsam ("Berlin. klin. Woch.," 1912, No. 12) (Ref. "Zentralblatt für Chir.," 1912, No. 23) excised an impermeable stricture 6 cm. in length and substituted for it 8 cm. of the long saphenous vein. The vein was drawn over a catheter (valves facing distally) and sutured with precision to the urethral stumps. The result was good.

Rupture of the Urethra.—Operative treatment of urethral rupture varies greatly according as the case is seen early or late, when infection and necrosis have taken place. Practically every case of urethral rupture demands prompt operation. It is rarely possible to introduce a catheter beyond the site of rupture; even when this is possible perineal section ought to be performed to evacuate effused blood and provide free drainage.

I. *Early Operations.*—Lithotomy position. Clean the perineum and its surroundings. Pass a sound through the penis down to the site of rupture. Expose the injured urethra exactly as in external urethrotomy. Find the

opening into the posterior segment of the urethra. This may be easy but is often extremely difficult. If, after reasonable search in the well retracted wound aided by reflected light and the use of probes, etc., the posterior urethra cannot be found, it is usually advised to incise in the median line further back, and so enter the intact portion of the posterior urethra and, by means of a probe passed from behind forwards, find the desired orifice. To the author it seems much better, under the above circumstances, to open the bladder above the pubis, practise retrograde catheterization, and subsequently drain or siphon the urine through the suprapubic wound.

When the site of injury has been well exposed, blood clots evacuated, injured shreds of tissue removed, the urethral wound may be (*a*) closed as after urethrectomy or (*b*) drained as after external urethrotomy.

If, when the patient is seen, he is in very poor condition from shock, do *not* immediately operate as above. Either evacuate the urine from the bladder by suprapubic aspiration and await reaction, or, guided by a sound passed into the urethra, cut down to and freely open the urethra at the site of injury, and making no search for the posterior opening into the urethra, trust to simple drainage. Simple drainage has stood the writer in good stead.

II. *Late Operation.*—Late operation, *i.e.*, operation after there is much infiltration of urine, distinct infection and necrosis of tissues, resolves itself into the treatment of the urinary infiltration and phlegmonous inflammation.

The operation is identical whether the trouble is due to a neglected traumatic rupture or to neglected stricture, etc.

A sound passed per urethram to the site of injury may be an aid; it is not a necessity, as the aim of the surgeon at this time is not to definitely open the urethra but to open the collections of pus, urine, etc., *in the tissues*. The urine will escape sufficiently through the opened abscesses. In the cases under consideration (only a few hours may have elapsed since the accident) the scrotum, penis, and perineum are usually very much swollen.

Lejars writes: "Don't try to catheterize. Don't waste time by making haphazard and insufficient incisions in the most œdematous zones; at once attack the perineum."

The Operation.—Lithotomy position. Cleanse and shave the perineum and surroundings. Retract the scrotum upwards. Make a median perineal incision about 1½ to 2 inches long. The posterior end of the incision must be at least one fingerbreadth from the anus to avoid injury to the sphincter. Continue deepening the incision until urine and pus escape freely. On account of the swelling, it may be necessary to penetrate 2 inches or more. Always keep to the middle line and persist until the fluid is found. Lejars makes the above incision with the thermocautery; the author has always used the knife.

When the urine and pus are found, explore with the finger and open up subsidiary cavities. If necessary make counter openings. Puncture or incise freely all greatly swollen regions, *e.g.*, on the scrotum and penis. Apply plentiful moist dressings. When the swelling and inflammation subside, incisions which at first seemed enormous become almost invisible. The whole

operation consists in making (*a*) free primary perineal incision, (*b*) free subsidiary incisions wherever necessary. It is better to make too many and too free incisions than too few and too small.

Late Operation in an Unusual Form of Urinary Infiltration.—When the urine escapes behind the triangular ligament, the territories infiltrated are the pelvis, the ischiorectal fossæ, and the hypogastrium. The penis, scrotum, and perineum are unaffected. The operative treatment required consists in free median incision above the pubis, in free opening of the ischiorectal fossæ, and in drainage of the bladder.

CHAPTER LII

EPISPADIAS

Epispadias is closely allied to hypospadias, and when there is curvature of the organ from fibrous tissue contraction this must be corrected in the same fashion as in hypospadias.

Thiersch's operation is performed in several stages:

I. Construction of urethra in the glans penis. Parallel to the groove in the glans make two incisions, as shown in Fig. 827, *a* and *b*. Lay a glass or metal rod along the groove, and with it depress the groove, at the same time sliding the lateral portions of the glans (mobilized by the two incisions) over the rod, and unite their raw surfaces by quill sutures (Fig. 827, *c*). When the balanic urethra is safely and firmly established and the wounds healed, proceed to

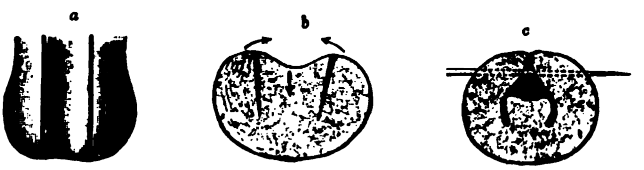


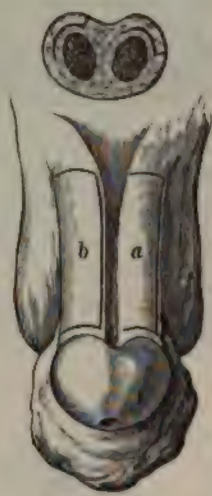
FIG. 827.—Thiersch's operation. (*Esmarch and Kowalzig.*)

II. Construct the penile urethra. Make the skin-flap *a* (Fig. 828) along the whole length of the urethral groove and with its base next the groove. Make the similar skin-flap *b*, with its base remote from the urethral groove. Turn the flap *a* over so that it covers, and has its skin surface next to, the groove. With a few points of suture fix the cut edge of flap *a* to the under or raw surface of flap *b*, near its base (Fig. 828). Pull flap *b* over flap *a* and suture its free edge to the raw surface on the penis left by the elevation of flap *a* (Fig. 829). In tracing out the two flaps *a* and *b*, the former is made narrower than the latter.

III. A small opening still exists between the new-formed tubes in the penis and glans. In epispadias the incomplete but usually redundant prepuce hangs below the glans. Make a transverse hole through the prepuce near its base (Fig. 829, *c*, *c*) and push the glans through it. The prepuce now lies on the top of the penis, and by suturing the edges of the wound in it to the vivified edges of the urethral defect, the latter can be closed (Fig. 830).

IV. A defect remains at the base of the penis. To close this, vivify the edges of the defect, and forming a flap (Fig. 831, *a'*), turn it over and suture its edges to the edges of the defect, thus providing an epidermal lining to the portion of the urethra covered. Another skin-flap (Fig. 831, *a*) is reflected and

made to cover the exposed raw surface of flap a'. This procedure is objectionable in that the skin-flap a will assuredly develop hair and cause trouble. It is far better to cover the opening with a single flap—raw surface inwards—as Cheyne recommends. The contraction which subsequently occurs is far less objectionable than the growth of hair inseparable from Thiersch's plan.



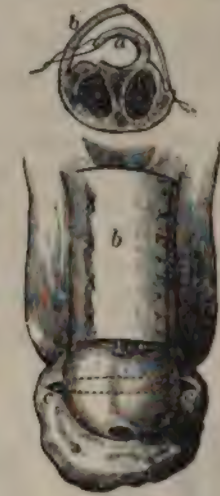


FIG. 828. FIG. 829.
FIGS. 828 AND 829.—Thiersch's operation. (*Esmarch and Kowalzig.*)

FIG. 830. FIG. 831.
FIGS. 830 AND 831.—Thiersch's operation. (*Esmarch and Kowalzig.*)

As is stated in the chapter on "Hypospadias," all operations which provide an epidermal lining for the new urethra from skin in which hair is liable to grow are very objectionable, hence Rosenberger's ingenious and simple operation is to be condemned and will not be described.

The Van Hook-Mayo operation for hypospadias is entirely suitable in cases of epispadias.

Cantwell's Operation—This most ingenious and logical operation ("Annals Surg.," Dec., 1895) seems to have been unaccountably overlooked. The author is indebted to Wetherill for drawing his attention to it.

Step 1.—Open the bladder through the perineum and introduce a Watson drainage-tube.

Step 2.—Recognize the line of junction between the mucosa of the gutter-like urethra and the skin of the penis. On each side of the urethral groove make a longitudinal incision along these lines of muco-cutaneous junction, from the symphysis to the extremity of the glans. (Fig. 832, *a*.) Unite the incisions above the opening into the bladder. The incisions penetrate to, but must not injure the corpora cavernosa. Separate the urethra, as a flap, from its bed and hold it aside. (Fig. 832, *b*.)

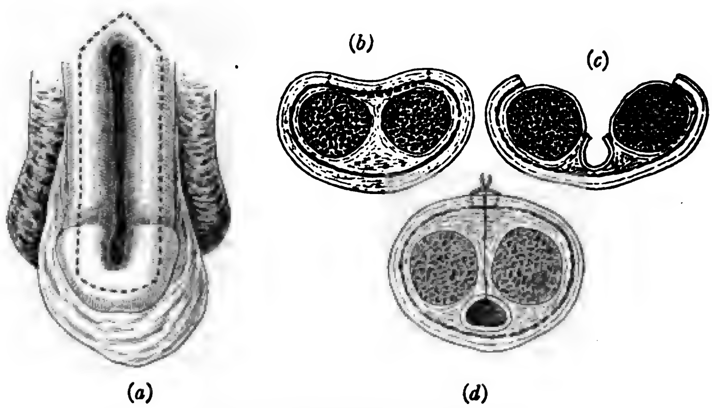


FIG. 832.—Cantwell's operation.

Step 3.—With sharp and blunt dissection separate the one corpus cavernosum from the other until the skin on the lower surface of the penis is reached. (Fig. 832, *c*.)

Step 4.—Place the mobilized urethra in the bottom of the long penile wound and fix it there by a couple of sutures.

Step 5.—Lay a sound or a glass rod along the urethra (which is a mere groove) and suture the urethra over the rod so as to form a tube. Remove the rod.

Step 6.—Bring the corpora cavernosa together over the urethra and close the wound. (Fig. 832, *d*.) The urethra now occupies its normal site.

Harold Stiles' Operation.—("Trans. Am. Surg., Assoc.," 1911.)

1. **Trendelenburg's Position.**—Subumbilical right rectus incision.

2. Divide the peritoneum covering the ureter where it crosses the termination of the internal iliac artery to go "downwards and forwards towards the base of the broad ligament, a little below the infundibulopelvic ligament and the ovarian vessels." Be careful to avoid injury to the ureteric vessels. By blunt dissection free the ureter with its vessels, up to the pelvic brim and down to the base

of the broad ligament. Ligate the ureter with catgut close to the bladder; apply a fine clamp to the ureter a little above the ligature; divide the ureter between the clamp and ligature; cauterize the distal stump. Prepare a fine catgut suture by threading each end on a fine needle. Pass the needles from within outwards through the whole thickness of the ureteric wall and distant from each other about one-third the circumference of the ureter. Wrap the mobilized ureter and the catgut suture with the needles still attached, in a pad of gauze.

3. Pull the lowest part of the pelvic colon into the wound and apply longitudinally to it a fine intestinal clamp in such a manner as to segregate the antimesenteric edge of it for about 3 inches (Fig. 833). Make a very small cut transversely through the gut wall down to but not through the mucosa at the junction of the middle and lower thirds of the clamped-off portion. Make

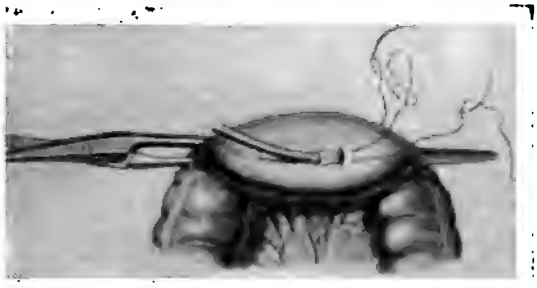


FIG. 833.

a small opening through the mucosa. Pass the two needles of the ureteric suture through the mucosal wound and make them penetrate the wall of the gut from within outwards. Push the end of the ureter into the gut. Tighten and tie the catgut suture. With silk or hemp, suture two parallel folds of gut wall over the implanted ureter and the original catgut stitch in the Witzel method (see Gastrostomy). The stitches should pick up a sero-muscular fold on the side of the ureter but must not enter its lumen. Remove the intestinal clamp.

4. Suture the divided peritoneum on the floor and posterior wall of the pelvis with catgut, leaving a small opening at the uppermost part for the passage of the ureter. It is important to make sure that the portion of ureter "which passes from the opening left in the peritoneum to the site of implantation should be as short as possible, and it is with this object in view that the implantation in the pelvic colon is made as near the rectum as possible." This to avoid risks of internal hernia.

5. Close the abdomen without drainage. Stiles operates on the other ureter from three to six weeks later.

CHAPTER LIII

HYPOSPADIAS

In hypospadias, owing to an error in development, the urethral floor is defective. The defect may be slight or great, and according to its degree the deformity is of the following types: (1) Balanic, *i.e.*, confined to the glans, the urethral meatus being immediately behind, while the balanic urethra is absent or represented by a mere groove or gutter. (2) Penile type. The urethral opening is situated at any point between the scrotum and the glans; the anterior urethra is absent or represented by a mere groove. (3) Perineo-scrotal type. The urethral opening is in the perineum and the scrotum is divided.

In any form of hypospadias except the mildest the defective penis is curved downwards, and held in a position of chordee by dense fibrous tissue bands which exist on its lower surface. These bands are an important element in treatment, as no operation can be of any value which does not correct the curvature. Duplay corrects the chordee deformity by making transverse incisions through the fibrous bands. The incisions may be subcutaneous or open, according as the skin is contracted or loose. When the incisions are open, they may be covered by skin-grafts or rendered longitudinal by means of sutures. Bleeding is not great, as any tissues divided are sclerosed. Some surgeons excise much of the scar tissue. The straightening of the penis must be thorough, if requisite, several incisions being employed. While healing is progressing the corrected position may be retained by strapping the penis to the belly-wall. (In cases of epispadias a splint is requisite.) Several weeks may be spent in obtaining a straight organ.

Where the deformity is of the balanic type, the foreskin may be complete or may be divided; in the latter case it is usually redundant and hangs over the glans as a hood. Operation is required because of narrowness of the urethral opening and because of the great inconvenience arising from the impossibility of directing the stream in urinating. If the urethra is represented by a groove on the under aspect of the glans, it may be converted into a tube by freshening its edges and uniting them over a glass rod, or by an operation identical with that of Thiersch. (See "Epispadias.")

In a case in which the above operation had been unsuccessful the author obtained a good result from utilizing the foreskin in the following way: Vivify one edge of the urethral groove (X Y, Fig. 834). Divide the foreskin along the line X Y. Suture the raw edge of the foreskin wound Y P, to the freshened edge of the urethral groove X Y (Fig. 835). Wait until union has taken place. Divide the foreskin along the line A B, Fig. 835. Freshen the corre-

sponding edge of the urethral groove. Unite with sutures the raw edge of the foreskin to the edge of the urethral groove. The result is shown in Fig. 836.

Beck's Operation.—Beck's operation is suitable, not only in cases where the urethra is defective at the glans, but where it is defective for a short distance behind it.

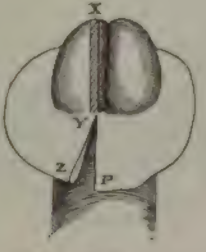


FIG. 834.

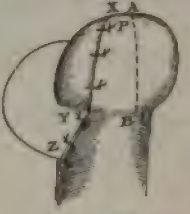


FIG. 835.

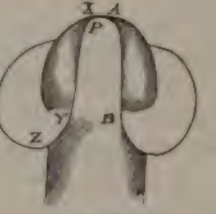


FIG. 836.

Dissect the distal end of the complete urethra free from its surroundings for a suitable distance (Figs. 837, 838, 839, 840). This mobilizes the tube so that it can be pulled forwards and sutured to the vivified urethral groove on the under surface of the glans. Where there is no urethral groove on

FIG. 837.

FIG. 838.

FIGS. 837 AND 838.—(*Beck.*)

the glans, some surgeons perforate the glans from before backwards or from above downwards and backwards (Ochsner) and pull the mobilized end of the urethra through the tunnel, suturing it there. When the defect belongs to the penile or scroto-perineal type, other operations are required.

Duplay's Operation.—First sitting: Straightening of the penis.

Second sitting: Correction of the deformity in the glans, as in Thiersch's operation for epispadias.

Third sitting: Establish perineal drainage, by the boutonnière operation. C. H. Mayo advises the introduction of a Jacobs' self-retaining female catheter through the perineal wound. Correct the urethral deformity as follows: Make a longitudinal incision (A, B, Fig. 841) parallel to and about 3/8 inch distant from the edge of the urethral groove. At each end of this incision make a transverse incision beginning at the edge of the urethral groove and ending at a point well external to the longitudinal cut. These cuts outline

FIG. 839.

FIG. 840.

FIGS. 839 AND 840.—(*Beck.*)

two flaps, one of which (X, Fig. 841) has its base at the urethral groove; the other, P, has its base towards the side of the penis. Reflect these flaps. On the opposite side of the urethral groove duplicate the above incisions and form the flaps Y and Q. Pass a rod through the lately formed urethra of the glans and permit it to lie in the urethral groove. Reflect the flaps X, Y, on to the rod (Fig. 842) so that their epidermal surfaces next to the rod and their raw surfaces are exposed. These two flaps should *not* be so wide that their edges meet over the rod. Approximate the flaps P and Q by means of the suture S S[1] (Fig. 842). The skin is so loosely attached to the penis that it is easy to slide the flaps P and Q inwards so that their raw surfaces are partly in contact with those of X and Y and partly with one another. The sutures, of silkworm-gut or silver wire, should be fastened to perforated lead plates which extend

the whole length of the wound on each side of it (quill sutures). The lead plates prevent the sutures cutting out and assist in keeping the parts at rest.

The above operation is a modification of Duplay's operation for epispadias. After the penile urethra is completely formed there is still a hiatus between it and the urethra leading from the bladder. This hiatus is closed in the manner described in the chapter on "Epispadias."

FIG. 841.—Duplay's operation.

Thiersch's operation for epispadias is also suitable in hypospadias.

Many ingenious operations have been devised by which a new urethra is formed from the skin of the scrotum (Rosenberger, Wood, etc.). All these are objectionable in that hair will grow on the skin used in the making of the new urethra and cause an infinity of trouble.

Nové-Josserand has devised a most ingenious method of operating, but whether it will prove of much value or not is still doubtful. The operation is performed as follows: Divide the skin transversely immediately in front of the urethral opening (A, Fig. 843). From this cut make a subcutaneous tunnel, by means of a trocar, to the point of the penis. Cut a large Thiersch skin-graft and roll it around a glass rod, fixing it to the rod by means of a ligature at each end (Fig. 844). Pass the rod covered with the graft through the newly made tunnel in the penis. Apply dressings. After eight days remove the rod. It will be wise to drain the bladder by means of a Jacobs' self-retaining catheter introduced through a perineal incision, and thus avoid contamination of the wound with urine. For a few months after recovery pass sounds at intervals, as there is a tendency to contraction. Various materials have been used to take the place of skin in the Nové-Josserand operation. Schmieden has implanted a ureter obtained during an operation for hydronephrosis; experimentally an artery has been utilized. Tanton published in 1909 an experiment in which he replaced the urethra by implanting a segment of vein. Tanton, Tuffier, Stettiner, have applied this experiment to man and have been successful ("Journal de Chir.," June, 1910).

FIG. 842.—Duplay's operation.

The operation for the posterior penile type of hypospadias is performed in two stages at an interval of from two to five weeks.

First Stage.—(*a*) Correct the chordee as already described.

(*b*) Provide for suprapubic drainage through as small an incision as possible and without suturing the bladder to the skin. Keep the bladder clean by frequent irrigations with a mild antiseptic solution. Change the drainage tube at intervals as it becomes encrusted with urinary salts.

Second Stage.—(*a*) Excise a segment of the internal saphenous vein. The

segment ought to be about 50 per cent. longer than the portion of urethra to be constructed, as the excised vein shrinks greatly. Wash the vein and preserve it in warm salt solution.

(*b*) Introduce a sound into the hypospadiac opening and mobilize the urethra around the sound by careful dissection.

(*c*) Make a tunnel as in the Nové-Josserand operation from the glans through the penis to the incision around the mobilized urethral opening.

(*d*) With vaseline lubricate a bougie and pass it through the segment of vein obtained in step *a*.

(*e*) Pass the bougie, with the vein on it, through the tunnnel made in the penis and make the point of the bougie go into the mobilized urethral orifice.

Fig. 843.

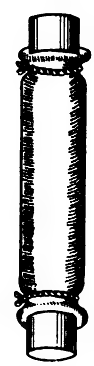


Fig. 844.

Figs. 843 and 844.—Nové-Josserand's operation. (*Monod and Vanverts.*)

(*f*) Suture the open end of the vein to the open end of the mobilized urethral orifice by means of mattress sutures which cause eversion. (To the author this seems bad practice, as it must bring the inner surface of the vein into apposition with the inner or *epithelial* surface of the urethra, a condition which must be inimical to healing.)

(*g*) Having anastomosed the implanted vein to the urethral orifice, close the wound on the under surface of the penis (or perineum) with one or two rows of sutures. Place a very small drain under the skin for twenty-four or forty-eight hours.

(*h*) Unite the other end of the vein to the edges of the wound in the glans. Remove the bougie.

After-treatment.—Remove the drain after twenty-four to forty-eight hours. After the lapse of five or six days inject, ***most gently***, enough sterile olive oil to slightly distend the new urethra. Repeat the injection daily. After about two weeks begin the use of sounds, but use them gently and at intervals of two to three days. Only after the lapse of about one month is it proper to pass sounds large enough to really dilate the new urethra. When the new urethra has become thoroughly acclimatized introduce a catheter and leave it in place until the hypogastric fistula has closed.

Tanton's operation promises well, but late results have not yet been reported.

Van Hook ("Annals of Surgery," April, 1896) and C. H. Mayo ("Journ. Am. Med. Assoc.," April, 1901) have devised very similar operations which may be performed as follows:


FIG. 845.


FIG. 846.

FIGS. 845 AND 846.—(*C. H. Mayo.*)

"The prepuce is extended as for circumcision and two incisions are made, about 1 inch apart, extending from its border to its attachment at the penile cervix; the prepuce is unfolded, forming a loop of thin skin about 2½ inches in length. Should this not be considered sufficient to reach from its attachment to the hypospadiac opening, the two incisions are extended back along the dorsum of the penis until sufficient tissue is obtained, where the two incisions are connected by a transverse one, and the flap of skin lifted but left attached to the cervix by the inner surface. Several sutures now close the lateral integument over the denuded area (Fig. 845). The pedunculated flap of prepuce is constructed into a tube with its skin or outer surface inside, by means of a number of catgut sutures. The penis is tunneled by means of a narrow bistoury or medium trocar and cannula, through the glans, above its groove, along the penis to a point beneath the hypospadiac opening, when it is made to emerge at one side of, but close to, the urethra; the tube of prepuce is drawn through the tunnel and sutured where it enters the glans and also where it emerges (Fig. 846). At the end of ten days the pedicle of the flap is cut through close to the new meatus. The second operation, made at a

later period, consists of a perineal opening into the urethra and insertion of a Jacobs' self-retaining female catheter; this is the least irritating form of catheter and can be left as long as needed—usually from five to eight days. An incision at the termination of the two urethras now admits of accurate coaptation by sutures, or the normal urethra may be mobilized (Beck method)

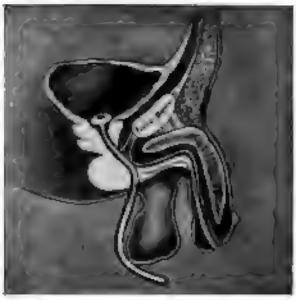


FIG. 847.—(*C. H. Mayo.*)

to a sufficient extent to admit of its insertion into the new urethra, where it is held by sutures and the external parts closed over this (Fig. 847). Occasionally a little urine escapes into the urethra, and the entire canal is best drained by passing several strands of silkworm-gut or horse-hair through the urethra and out alongside the catheter in the perineal opening."

CHAPTER LIV

AMPUTATION OF PENIS

Partial Amputation.—I. *Amputation of Glans and Part of Penis.—Step* 1.—Apply an elastic constrictor to the root of the penis. Make an incision through the skin completely round the penis and at least ¾ inch distant from the disease. Retract or reflect the skin upwards for about ½ inch. (The natural elasticity of the skin will produce enough retraction without the aid of the surgeon.)

Step 2.—Expose and ligate the dorsal artery and veins of the penis.

Step 3.—Divide the corpora cavernosa transversely. At a point nearly ½ inch farther forward divide the urethra transversely.

Step 4.—With catgut suture the ends of the corpora cavernosa (Fig. 848). This assures hæmostasis.

Step 5.—In the middle line below make a short incision through the skin. Make a corresponding cut in the urethra (Figs. 848 and 849). Suture the split urethra to the skin. This splitting and suturing prevents contraction.

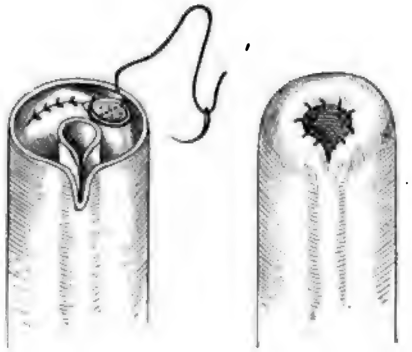


Fig. 848. Fig. 849.
Figs. 848 and 849.—Amputation of penis.

Nicoll, most sensibly, modifies the operation as follows: Step (*a*): Make an incision over each inguinal region. Unite these incisions in the middle line at the root of the penis and from their point of union make an incision along the mid-dorsal line of the penis to the place chosen for amputation. Step (*b*): Beginning at each groin dissect free, from the outside inwards, the lymphatics of the groins and then, from above downwards, those of the dorsum of the penis. Remove all these lymphatics in one piece. After this proceed to amputate.

II. *Complete Amputation.* (Gould's method.)—Place in lithotomy position.

Step 1.—Split the scrotum completely along raphé, and thoroughly expose the corpus spongiosum.

Step 2.—Pass a sound through the urethra to the triangular ligament. Separate the corpus spongiosum from the corpora cavernosa. Remove the sound. Divide the corpus spongiosum and isolate the urethra as far as the triangular ligament.

Step 3.—Continue the scrotal incision through the skin around the root of the penis. Divide the suspensory ligament. Separate the crura from the

pubic bones. The only vessels requiring ligation are those of the crura. This completes the amputation.

Step 4.—Make a short split in the urethral stump. Suture the edges of the split urethra to the posterior portion of the scrotal wound.

Step 5.—Suture the skin wound after providing for drainage.

Remarks.—Very good results have been obtained by the above operations with or without removal of the inguinal lymph glands. Cancer of the penis is usually of comparatively slow growth. Recurrence usually is in the lymph glands. Butlin advises removal of the inguinal glands as a secondary operation. If the urethra is split and united to the skin as described, difficulties in micturition are largely avoided. Amputation at the junction of the middle and distal third or at the middle of the penis does not necessarily destroy the power of coitus and begetting (Butlin). The danger of the operations described is not much over 2 per cent.

III. *Emasculation.*—If the disease is extensive or of rapid growth a much more serious and radical operation is proper. This operation is based on a study of the penile lymphatics.

The lymphatics of the penile skin and of the prepuce anastomose freely and drain into the superficial lymphatic glands on *both* sides. The lymphatics of the glans pass up along with the dorsal veins of the penis to a few lymphatic glands which lie in front of the pubis; from this point they take two courses: (*a*) to deeply located glands lying on the inner side of the femoral vein, (*b*) along the inguinal canal under the spermatic cord.

From the above (see "Traité d'Anatomie Humaine," Poirier et Charpy, Tome II) it is evident that it is safe to make a difference in the extent of operation according as the glans is involved or not. If the glans is not affected a theoretically complete operation means removal of the superficial lymph glands from both inguinal regions, removal of the penis and removal of the lymph channels between the penis and the lymph glands. If the glans is also involved a theoretically complete operation means removal of the above structures *plus* the deep inguinal glands to the inner side of the femoral vein and *plus* the lymphatics under the cord in the inguinal canal and *plus* the prepubic glands. Technically it may be possible to do all this and preserve the scrotum and testicles, practically it seems better to remove these organs also. In the operation to be described it is assumed that the glans is affected. The method is one which the writer elaborated for his own use, but which is, of course, not original.

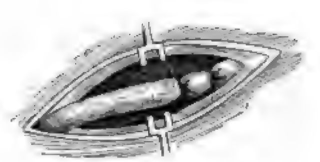


FIG. 850.—Exposure and Ligation of cord high up.

Step 1.—After the usual cleansing and shaving of the whole operative territory, clean the diseased parts as well as possible, swabbing them with Harrington's solution or liquid carbolic or even touching them with the cautery. Apply dressings to the disease and cover them with oiled silk. Suture the

dressings or coverings to the skin of the penis. These precautions are taken to prevent infection. Once more clean the operative territory.

Step 2.—Make an incision over the inguinal canal parallel to Poupart's ligament. Open the canal by splitting the aponeurosis of the external oblique. Lift up and mobilize the spermatic cord and all the fat surrounding it. Doubly ligate and divide these structures as high up as possible (Fig. 850). Obliter-

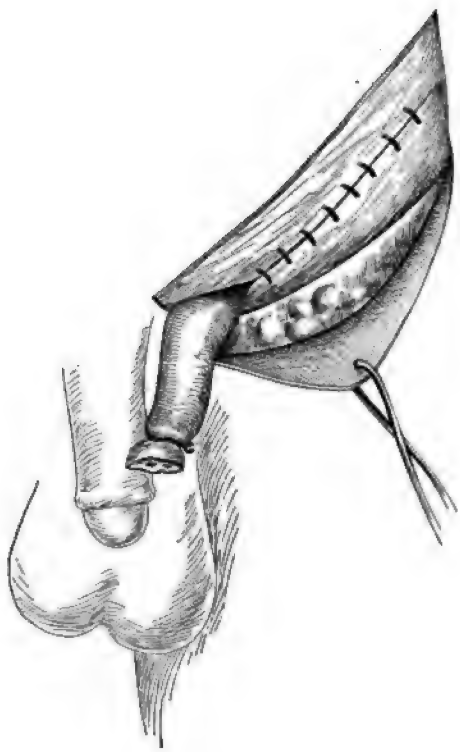


FIG. 851.—Closure of inguinal canal.

ate the now empty inguinal canal by suturing the wound in the aponeurosis (Fig. 851).

Step 3.—Through the original wound, supplemented if necessary by a subsidiary incision, expose Scarpa's triangle above the saphenous opening (Fig. 851). Beginning at the lower and outer sides of the exposed area, dissect the superficial inguinal glands, along with the fat surrounding them, upwards and inwards towards the pubis.

Step 4.—Expose and remove the deep inguinal glands. These vary in number from 1 to 3. When three are present one lies just below the long saphenous vein, one in the femoral canal, and one in the femoral ring. All are to the inner side of the femoral vein.

Step 5.—Repeat steps 2, 3, 4 on the opposite side. Incise the skin immediately above the root of the penis, uniting by this cut the two incisions over the inguinal canals. On each side of the root of the penis make an incision downwards over the root of the scrotum. Dissect downwards the fat in front of the pubis, until the crura of the penis are exposed. Divide the suspensory ligament. The results of the work accomplished up to this point are: (*a*) All the lymphatic glands and tissue which may presumably be affected are dissected up and now hang, along with the spermatic cords and the prepubic fat, attached to the penis and scrotum (Fig. 852). The inguinal canals which were opened have been closed. Any wound which may have been made to expose Scarpa's triangle may now be closed.

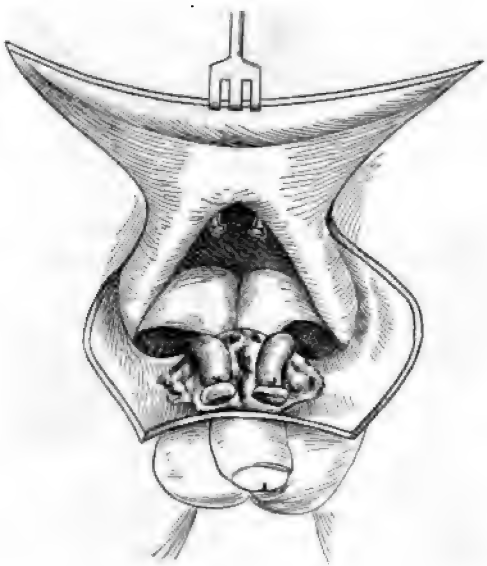


FIG. 852.—Operation of emasculation.

Step 6.—Working from above downwards, separate the crura of the penis from the pubic bones. Complete the incision through the scrotum below and behind. Expose and mobilize the corpus spongiosum at the root of the scrotum. Divide the corpus spongiosum and urethra. A few catgut sutures through the cavernous tissue prevent hemorrhage. It is now easy to remove, *in one piece*, the penis, scrotum with its contents, superficial inguinal glands, and the lymphatics of the inguinal canal. (The deep inguinal glands were removed separately.)

Step 7.—Make a slight split in the urethral stump and suture the edges of the urethral wound to the most posterior part of the cutaneous wound. Close the extensive skin wound with sutures after providing, where necessary, for drainage.

N.B.—When removing the scrotum it is well to leave enough of its posterior wall to be brought forward and upward and united to the edge of the wound across the pubis. When this is done the urethra can be brought through a button-hole cut in the base of the scrotal flap (Fig. 853). When removing

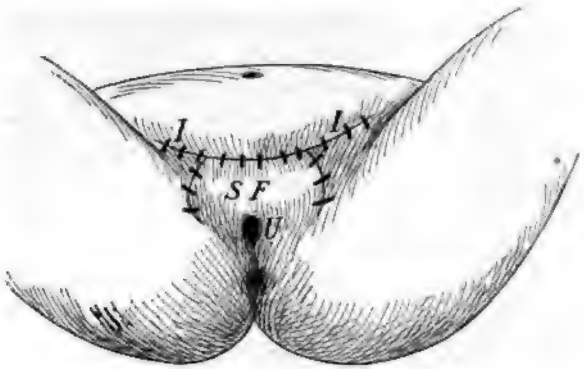


FIG. 853.
I, I. Inguinal wounds. *SF.* Scrotal flap. *U.* Urethral opening.

the scrotum v. Dittel retained a portion of the posterior scrotal skin which he wrapped around the stump of the corpus spongiosum (left long for this purpose). The effect of this detail was the formation of a sort of "spout" which enabled the patient to urinate without taking down his trousers.

CHAPTER LV

CIRCUMCISION

There are several methods of performing circumcision; most of these are merely modifications of the following:

Classical Method.—Feel and locate the corona or groove behind the glans penis; the prepuce being in normal position is not retracted. Place a clamp (the handles of a long scissors form an efficient clamp) on the skin corresponding to the corona. Gently tighten the clamp so as to hold the skin between its blades and yet permit the glans to be pushed back behind it. Push back the glans so that it lies in safety behind the clamp. Tighten the grasp of the clamp. The whole skin and part of the mucous membrane of the prepuce now lie in front of the clamp; the glans and part of the mucous membrane of the foreskin lie behind it.

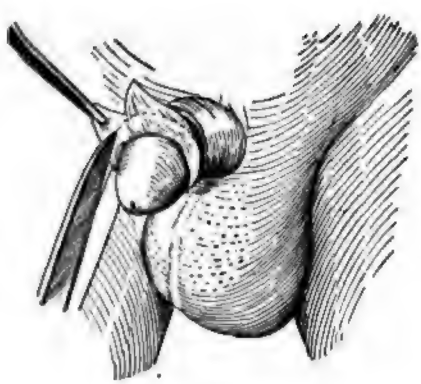


Fig. 854.

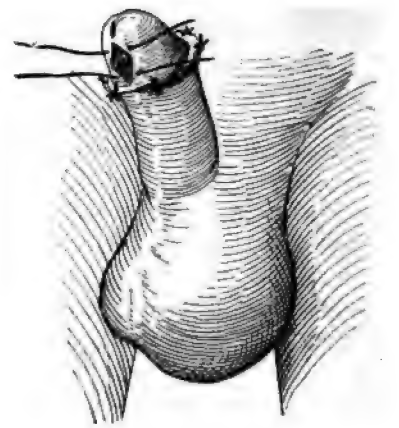


Fig. 855.

Figs. 854 and 855.—Circumcision. (*Veau.*)

Remove, with a knife, all the structures in front of the clamp. Remove the clamp. The skin retracts to the root of the penis; the glans is covered by a tube of mucous membrane having a raw and bleeding external surface. Cut away (Fig. 854) all except about 1/3 inch of the mucous membrane. If the frenum is short and pulls the glans downwards and backwards, divide that structure *transversely* and in suturing convert the transverse into a longitudinal wound, thus lengthening the frenum (Fig. 855). Pull the skin forwards and suture it to the mucous membrane. Apply vaseline or some ointment to the wound and protect with a small piece of gauze. No elaborate dressings are of any value. Warn the patient or his mother that the penis will become swollen

and discolored; this warning may prevent the operator being summoned to treat non-existent hemorrhage. Serious post-operative hemorrhage is rare. Before operating, especially if cocaine is used, it is well to apply an elastic constrictor round the root of the penis.

A Typical Operation.—With scissors or knife split the prepuce in the mid-dorsal line to the corona. Beginning at the angle of the wound trim away as much of the redundant tissues as may seem necessary. Stitch the skin to the mucous membrane.

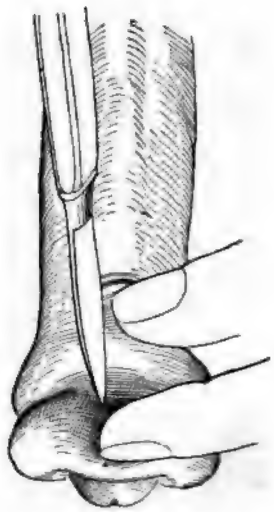


FIG. 856.—Paraphimosis. (*Veau.*)

Many surgeons omit the removal of any tissue after splitting, but this, at least temporarily, leaves the foreskin hanging below the glans like an elephant's ear and causes much annoyance to the sensitively inclined.

The adhesions which so commonly exist between the prepuce and the glans are as a rule easily separated, but occasionally they are so firm as to require sharp dissection. In such a case the author, after dissecting the prepuce from the glans, folded the redundant prepuce on itself so that a short prepuce was formed lined with epidermis and so reformation of adhesions was prevented. Possibly it would have been well to have covered the raw surface of the glans with skin grafts.

Paraphimosis.—The foreskin is retracted, swollen, and cannot be brought forwards. The constricting band obstructing reduction is the margin of the preputial orifice (the mucocutaneous junction). The retracted foreskin forms two swellings surrounding the penis; the constricting band lies in the groove between the swellings.

A. By manipulations endeavor to push back the glans and bring forwards the prepuce. If successful, advise or perform circumcision to prevent recurrence.

B. If manipulation fails, operate. With the fingers separate the anterior from the posterior penile swellings and so expose the constricting band. Divide the band in the mid-dorsal line; reduction is now easy (Fig. 856). Advise or practise circumcision.

CHAPTER LVI

OPERATIONS ON THE TESTICLES

CASTRATION; ORCHIDECTOMY; ORCHI-EPIDIDYMECTOMY

I. Simple Castration.—*Step* 1.—Make an incision 2 or 2½ inches in length downwards from the level of the external abdominal ring. Through this isolate the spermatic cord by blunt dissection.

Step 2.—If the cord is not very thick, crush it forcibly with powerful forceps. In the groove formed by the clamp tie a ligature tightly around the whole cord. Thread one end of the ligature on a needle and pass it through a small portion of the cord distal to the main ligature. Once more tie. This stitch obviates any possibility of the ligature slipping. Some surgeons carefully avoid including the vas deferens in the ligature lest pain result. Jacobson believes that if the ligature be applied very tightly pain will not develop. Crushing the cord before applying the ligature has the same effect. When the cord is large, or if for any reason a single ligature seems objectionable, two or more interlocked ligatures may be applied. Absorbable or non-absorbable ligatures may be used at the option of the surgeon. Plain or iodized catgut serves every purpose excellently. Apply a clamp to the cord, about one inch distal to the ligature. Divide the cord between the clamp and ligature. Examine the ligated stump, which may be allowed to retract into the inguinal canal if it is healthy and is not bleeding.

Step 3.—With the hand on the scrotum make the testicle with its coverings protrude through the wound. By blunt dissection, separate it with its coverings from the scrotum, and so remove it.

Step 4.—Carefully review the wound and stop all bleeding. If drainage is required, perforate the scrotum at a dependent point, and through the perforation introduce a capillary or tubular drain.

Step 5.—Close the wound with sutures. The objects in making the skin-incision at a high rather than a low level are: (*a*) It is more easy to separate the cord and the testicle from their surroundings; (*b*) the whole vascular supply is under control from the beginning; (*c*) it is much easier to retain suitable dressings over the wound.

II. Castration for Malignant Disease.—This operation as commonly performed is a farce and recurrence is certain. The usually described method is that of simple castration, which is as ineffective as simple excision of the cancerous breast when the axillary glands are involved. When the testicle is the seat of malignant disease, the same principle holds good as in the case of the breast, viz., to remove *en masse* the whole organ plus all the *accessible*

lymphatic tissue through which it is normally drained. Unfortunately, the terminal lymphatics are not accessible. The lymphatics of the testicle, epididymis, and visceral layer of the tunica vaginalis run along the spermatic cord to the lumbar region. They are usually superficial to, but in contact with, the blood-vessels. In the lumbar region they leave the spermatic vessels and run towards their terminal glands. The terminal glands are grouped around the aorta (right and left juxta-aortic glands) (Cuneo). The lymphatics of the scrotum terminate in the inguinal glands.

Cumston and Rolfe ("American Med.," 1903, 607) have given a good description of the methods to be employed; the following is largely based on their paper.

Step 1.—Make an incision parallel to and one inch above Poupart's ligament from a point a little below the external inguinal ring to a point about one inch above the internal ring.

Step 2.—Expose the fascia of the external oblique and split it, as in Bassini's hernial operation, from the external ring to a little above the internal ring. Retract the flaps of fascia thus formed.

Step 3.—Push the internal oblique muscle aside and thus expose the inguinal canal and spermatic cord. Dissect the cord from its bed. Open the posterior wall of the inguinal canal and invade the iliac fossa.

Step 4.—The elements composing the cord become separated at the internal ring, the vas going down towards the small pelvis, the spermatic vessels and lymphatics going up towards the lumbar region, on the psoas muscle. Follow the vas deferens as far as possible towards the deep pelvis and there ligate and divide it. Cauterize its stump with pure carbolic acid or the cautery. Follow the spermatic vessels up towards the lumbar region as far as possible and there doubly ligate and divide them.

Step 5.—Beginning above at the site of division of the vas and of the spermatic vessels, separate the cord and its envelopes downwards, to a point below the external inguinal ring. By pressing on the scrotum it is easy to deliver the testicle with its envelopes through the wound and remove them together with the cord. If the scrotum is adherent to the testicle, make a liberal excision of the scrotal skin and all the structures between it and the testicle. This is done by continuing the original incision downwards and making it surround the affected area. Remember that if the scrotum is involved the inguinal lymphatic glands may be affected and should be removed, as it is into them that the scrotal lymphatics drain.

Step 6.—Review the wound with care and attend to hemostasis. Close the wound exactly as in an operation for the radical cure of hernia.

Epididymectomy.—This operation may be done alone or vasectomy may be added to it.

Step 1.—Make an incision into the tunica vaginalis, just external and parallel to the epididymis. If the epididymis is adherent to the skin or fistulæ are present, such adherent skin and fistulæ should be surrounded by elliptical incisions and removed with the epididymis.

ɪ.—Make an incision along the junction between the epididymis cle on the *outer side*. This incision divides the serous membrane osite the body of the epididymis, while at the head and tail (globus d minor) it divides the tunica albuginea. With knife or scissors the head (globus major) from the testicle. Next spearate the body didymis from the testicle (Fig. 857). As the *inner* side of the junction the epididymis and testicle is reached, proceed with great care, be- e the vessels going to the testicle are in contact with the epididymis. ıg slight traction and putting the structures of the cord gently on h, it becomes easy to separate the epididymis from the vessels.

.—The epididymis being free, continue the dissection by separating om its surroundings up to the internal ring, "where it is grasped on ; of its circumference with hemostatic ivided, and the lumen of the proximal rized with 95 per cent. carbolic acid d of a needle. The needle is to be pwards in the lumen for ½ inch and us membrane thoroughly cauterized." e proximal end of the vas. This is : in that it prevents infectious mate- voided from the vas into the tissues.

.—Review the wound made in the r the removal of the epididymis. If of disease are found, excise them by ɪped incisions and close the wounds catgut. Suture with catgut any ι the tunica albuginea. If the condi- sticle makes one suspect disease in it, ɔer to make an exploratory incision Such incision must be closed with tures should no further procedure be indicated.

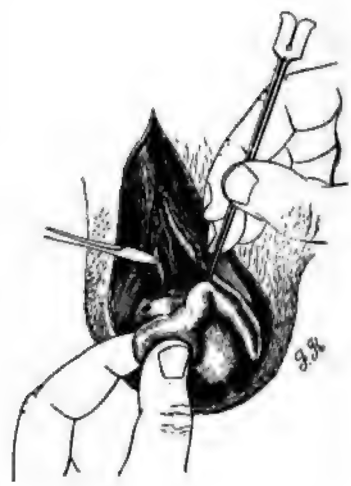


FIG. 857.—Epididymectomy. (*Monod and Vanverts.*)

.—Having attended to hemostasis, close the external wound with It is well to provide drainage for twenty-four or forty-eight hours. ıe cases it is possible to remove disease from the epididymis by partial te excision of that organ, without removing so much of the vas as ımended in the preceding paragraphs. When this is possible, one may : suggestion of Bardenheuer, which was first carried out by Rasum- Archiv f. klin. Chir.," lxv, p. 557), viz., to make an anastomosis he vas and the *rete testis* or the remnants of the epididymis.

: of the Vas Deferens after Division.—Accurate end-to-end anas- ıay be difficult because of the small lumen of the vas. W. I. deC. Brit. Med. Journ., Feb. 7, 1914) recommends the following method: point of a fine sewing needle into the lumen of one of the segments d slip the other segment of vas over the eye end of the needle until egments meet. Suture. After suturing make the needle, which is

inside the vas, penetrate its wall. Extract the needle. Cover and reinforce the line of suture with neighboring fascia.

Anastomosis between the Vas Deferens and the Rete Testis.—*Step* 1.—Completely excise the epididymis, removing as little of the vas deferens as possible.

Step 2.—Pass a fine probe or director into the vas and with this as a guide split the vas for a little less than half an inch.

Step 3.—With fine catgut sutures, introduced in the Lembert fashion, unite the gaping end of the vas to that part of the testicle from which the head of the epididymis was removed (rete testis, beginning of the coni vasculosi).

Step 4.—Partially bury in the testicle the site of anastomosis, by means of a few heavy sutures introduced in the Lembert fashion (Fig. 858).

Step 5.—Cover the line of sutures in the testicle by closing with catgut the wound in the tunica vaginalis, etc. Close the skin-wound.

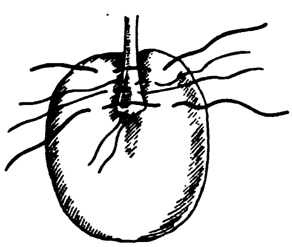


FIG. 858.—Anastomosis of vas to testis.

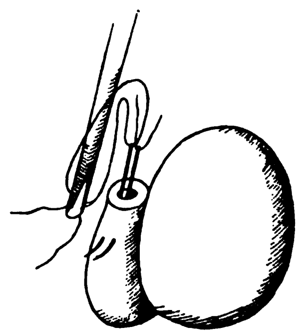


FIG. 859.—Anastomosis of vas to epididymis.

Anastomosis between the Vas Deferens and the Epididymis after Partial Excision of the Latter.—*Step* 1.—Excise the tail and part of the body of the epididymis, dividing the body transversely.

Step 2.—Split the vas for about ½ inch, and introduce into it (in the Lembert fashion) two fine catgut sutures.

Step 3.—Perforate or tunnel the remaining portion of the epididymis (head and part of body) with a pointed knife introduced through its cut surface. Through this tunnel pass by means of needles the catgut sutures attached to the vas (Fig. 859).

Step 4.—By pulling on the catgut threads insinuate the open end of the vas into the tunnel and fix it there by tying the catgut sutures. One or two extra sutures may be used to complete the union.

Step 5.—Close the wound in the overlying tissues by one or more layers of catgut sutures.

Excision of the Vas Deferens with or without the Seminal Vesicle; Vasectomy.—The term "vasectomy" is properly applied to this operation, but custom seems to have limited its use to the mere division or removal of a small segment of the vas in cases of prostatic hypertrophy. Vasectomy, in the latter

limited sense, is performed by incising the skin immediately below the external abdominal ring, exposing the cord, separating the vas from the other structures of the cord, and dividing it between two ligatures. J. W. White and R. Harrison have found much benefit result from this simple operation. Vasectomy, in the wider and proper sense of the term, is a much more serious procedure—so difficult, indeed, that a number of operators have discarded its use. Vasectomy may be *partial* or *complete*.

Partial Vasectomy.—The scrotum has been opened and the testicle or the epididymis has been excised. The divided end of the vas (if not still attached to the testis or epididymis) is seized in forceps to prevent its retraction. Continue the skin-incision upwards and outwards. Open the inguinal canal by incising the aponeurosis of the external oblique. Separate the vas from the cord up to or within the internal abdominal ring. Doubly ligate the vas at as high a point as possible and divide it, being careful to cauterize the stump. Attend to hemostasis and close the wound. In many cases this partial operation suffices.

Von Büngner, instead of excising the vas as above, merely follows it to the external abdominal ring and endeavors to remove the rest of it by avulsion, in the same manner as Thiersch extracts nerves. This method might be practicable if the vas to be removed was sound, but it is diseased and gives way at its weakest point, which is a diseased point. Theoretically, the method is bad.

Complete Vasectomy with or without Excision of the Seminal Vesicle.—Baudet and Duval have systematized this operation very thoroughly. Place the patient in Trendelenburg's position. Excise the testis or epididymis.

Step 1.—Continue the scrotal wound up to the external abdominal ring and along the inguinal canal to a point two fingerbreadths internal to the anterior superior iliac spine.

Step 2.—Open the inguinal canal by incising the aponeurosis of the external oblique. Divide the internal oblique and transversalis along the line of the skin-incision. Divide the transversalis fascia *without injuring the peritoneum.*

Step 3.—With the finger strip the peritoneum off the iliac fossa. Do *not* strip off any of the fascia with the peritoneum. It is important to keep between these two structures.

Step 4.—Incise the sheath of the spermatic cord and look for the vas beside the pubic spine. With blunt dissection follow and isolate the vas first towards the iliac fossa and then on the peritoneum, which is retracted inwards by a wide retractor. Do *not* exert any traction on the vas. Use the eye rather than the finger as a guide. During this dissection retract the epigastric artery forwards, the umbilical downwards and outwards. As the wound becomes deeper carry out the dissection with forceps. When a point deep down in the pelvis is reached, note a "tent-like" ridge passing transversely inwards from the pelvic wall. This is composed of the vesicular vessels covered by aponeurosis, and here the vas deferens enters the vesicular space. If the operation is

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to consist of complete vasectomy alone, doubly ligate the vas, divide and remove it. If it is desired to remove the seminal vesicle, proceed to Step 5.

Step 5.—Make a transverse tear in the fascia covering the vesicular vessels. Retract the edges of the fascial wound. Doubly ligate and divide the vessels. Beneath the vessels lies the pale, rather sinuous seminal vesicle.

Step 6.—Seize the base of the vesicle with a clamp and isolate it from its sheath, being careful, during the dissection, to keep in close contact with the vesicle so as to avoid hemorrhage. The deep portion of the vas is easily separated from the peritoneum and bladder; it lies along the inner side of and is closely attached to the vesicle.

Step 7.—With scissors separate the vas and seminal vesicle from the prostate. Cauterize the stump.

Step 8.—The most of the huge wound promptly closes itself as soon as the retractors are removed. It is well to place a cigarette drain into the depth of the wound. Close the wound in the parietes in the same fashion as in the radical cure of hernia.

Young's Operation.—("Annals of Surgery," Oct., 1900, and Nov., 1901.) "Suprapubic retrocystic extraperitoneal resection of the seminal vesicles and vasa deferentia." In several cases Young has successfully performed this most difficult operation, and has at the same time excised portions of the urinary bladder.

Make a vertical median incision from the pubis to a point above the umbilicus. At the upper end of this make a transverse incision dividing both recti muscles. These incisions penetrate to but do not involve the peritoneum. Retract the edges of the wound. Beginning below, dissect the peritoneum from the anterior bladder-wall up to and including the vertex of the bladder. At the vertex the separation is difficult. Continue the separation down the posterior bladder-wall until the seminal vesicles and vasa deferentia are exposed. Remove these, and with them any diseased portions of the prostate and bladder. (Young has removed about one-half of the bladder.) Close the bladder wound by sutures. Provide for drainage. Close the abdominal wound.

Several methods have been devised for the exposure and removal of the seminal vesicles through the peritoneum. These are so similar to some of the methods described for the exposure of the prostate that they need not be dilated upon. Schede has used the sacral and parasacral routes to reach the seminal vesicles, but other routes seem as efficient and much less formidable.

Remarks on Castration, Epididymectomy, Vasectomy, and Vesiculectomy. —In cases of malignant disease of the testicle or epididymis it is necessary to abide by the rule, do too much rather than too little. The freest possible excision of all tissue which may possibly be infected is compulsory, whether that tissue shows any signs or not. Only by conscientiously working along the lines of thoroughness can improved results be obtained. When the disease necessitating operation is tuberculosis, no such "hard-and-fast" rules meet

with universal approval. König more than any other surgeon has advanced our knowledge of the surgery of tuberculosis, and hence his opinion ought to carry great weight. This surgeon, and with him Kocher, Terrilon, Senn, etc., declares in favor of castration (orchidectomy) in cases of tuberculosis suitable for operation. When epididymectomy is performed, it is feared that tuberculous foci may be left in the testicle and cause further trouble, and it is assumed that no useful function can be performed by the imperfect organ left behind. J. B. Murphy, Tillaux, and others draw attention to the fact that the testicle has a useful influence on the general metabolism which must not be disregarded. The glandular portion of the testicle is practically never primarily and rarely secondarily affected to a serious extent. The results of Bardenheuer and Murphy show that epididymectomy is as curative as is castration. In suitable cases it may be well to attempt anastomosing the vas to the testicle. Bogoljuboff's experiments "(Archiv f. klin. Chir.," lxxii, p. 449) show that this operation does actually provide direct communication between the tubules of the testicles and the vas. The status of the operation is, however, by no means fixed as yet.

J. B. Murphy considers epididymectomy contraindicated (1) where there are extensive tubercular lesions elsewhere which will shortly terminate the patient's life. (2) Where the disease has extended to and destroyed the greater part or all of the testis proper. Here castration should be done. (3) Where the scrotum is riddled with discharging sinuses. The indication is usually here also for castration. Apart from these three conditions, in every case a resection, typical or atypical, should be done. Murphy also points out that after epididymectomy (without anastomosis) "sexual desire and potency, even to emissions, are retained; power of procreation, however, is lost."

Horwitz comes to conclusions which are very similar to and support those of Murphy.

In a large number of cases in which there has been evidence of involvement of the vas, seminal vesicle, and even bladder, simple epididymectomy, with or without any extensive vasectomy, has given excellent results. In these cases it appears as if nature was able successfully to combat the secondary lesions when the primary one was eliminated. The profound influence exerted on the prostate, etc., by castration or epididymectomy probably effectually aids nature in her combat.

When the gravity of operations for complete vasectomy and vesiculectomy is considered, and the frequency with which all evidences of disease disappear from the neck of the bladder after simple epididymectomy and partial vasectomy, it appears wise to be conservative.. Young's advice is excellent, viz., to abstain from operations on the seminal vesicles and prostate until such time as it is demonstrated that removal of the testicular foci has failed to arrest the progress of the disease in these organs and it has spread to the bladder. According to Young serious involvement of distant parts, pulmonary, urinary, osseous, etc., does not contraindicate operation. Removal of the local lesions often has a very satisfactory effect on the distant foci.

Epididymotomy.—C. P. Knight ("Journ. A. M. A., Jan. 31, 1914) warmly recommends epididymotomy in the treatment of acute epididymitis as it is without danger, relieves pain promptly and saves much time.

Local anesthesia. Make an incision about $1\frac{1}{2}$ inches below the lower border of the external ring and prolong it sufficiently to permit free delivery of the testicle and the tunica vaginalis. Wrap the testicle in gauze moistened with warm salt solution. Make a small incision in the tunica vaginalis. Expose the epididymis and puncture, 10 or 12 times, that part of it which appears inflamed. Use a large blunt needle for making the punctures. Wash with sterile water. Reduce the testicle. Suture the cut in the tunica vaginalis, Close the skin wound. Dress. The anesthetic agent (1 per cent. novocaine) is injected into the skin, the tunica vaginalis and the epididymis.

Operative Treatment of Undescended and Misplaced Testicle.—There are several types of undescended and misplaced testicle. The testis may be situated (*a*) in the abdomen near its original position; (*b*) at the internal ring; (*c*) in the inguinal canal; (*d*) outside the external ring; (*e*) in the perineum; (*f*) on the thigh below Poupart's ligament.

No matter where the testis is located, the principles of treatment are identical. These principles are: (1) Proper exposure of the organ. (2) Thorough relief of tension so that the organ may be brought into the desired place (the scrotum) and may tend to stay there of itself. (3) Proper preparation of the bed in which the testis is to lie. (4) Selection of proper time for operation. Undoubtedly the changes incident to puberty will take place more completely in the testicle when it lies in its natural position in the scrotum; hence the age of selection for operation is before puberty, when the patient is from six to twelve years old.

A. D. Bevan ("Jour. Am. Med. Assoc.," Sept. 19, 1903) has thrown much light on the condition under discussion, and the following paragraphs are based on his writings:

(A) The testicle is in the inguinal canal or outside the external ring.

Step 1.—Make an incision from the external ring upwards and outwards for a distance of three inches. This incision is like that made in Bassini's operation for inguinal hernia and does *not* involve the scrotum. Divide and retract the aponeurosis of the external oblique as in the hernia operation. Divide the cremasteric and thin transversalis fasciæ throughout the length of the wound.

Step 2.—Note the peritoneal pouch containing the testicle. Open this pouch and expose the testicle. Divide the peritoneum above the testicle and carefully separate it from the cord, as in a hernia operation. Close the stump of peritoneum by suture or ligature. With a purse-string suture close the portion of peritoneal sac in contact with the testicle and so form a tunica vaginalis (Fig. 860).

Step 3.—Lift the testicle out of its bed. Pull gently on the cord to lengthen it as much as possible. Shortened bands of connective tissue will be seen as tense bands in the cord. Tear through these bands with forceps. Strip the

. of all the surrounding fascia, leaving nothing but the vessels and the vas. ırate the spermatic vessels and vas, which lie behind the posterior layer of toneum of the abdominal cavity, from the peritoneum by blunt dissection. ıe spermatic vessels will be found passing upwards and inwards, and the

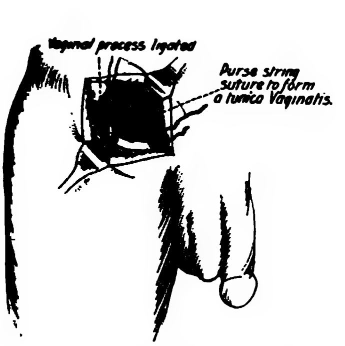


FIG. 860.

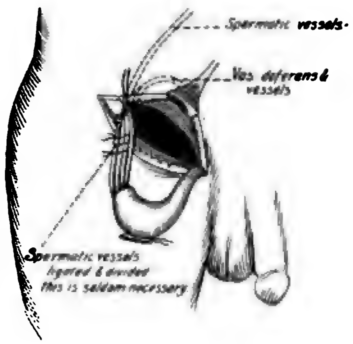


FIG. 861.

FIGS. 860 AND 861.—Bevan's operation. (*Bevan.*)

; downwards and inwards from the internal ring." The above manœuvres ıuld so lengthen the cord that the testicle may be laid on the thigh three or r inches below Poupart's ligament (Fig. 862). Unless lengthening of the d is obtained to the extent mentioned, other measures must be adopted to ure the requisite relief of tension.

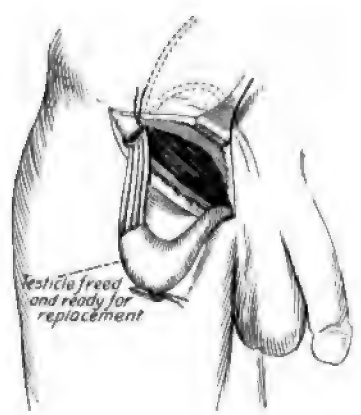


FIG. 862.—Bevan's operation. (*Bevan.*)

Step 4.—Pass the fingers from the wound into the scrotum and form a pocket e. Into this pocket tuck the testicle. Close the mouth of the pocket by ırse-string suture passing through both the external and internal pillars of external abdominal ring, above the cord. Do not let the suture exercise ure on the cord.

Ombrédanne ("La Presse Med.," Oct. 8, 1910) passes a finger from the wound into the bottom of the scrotum on the same side and then pushes the finger transversely through the septum into the other side of the scrotum where he incises the skin (Fig. 863). A forceps passed the scrotal skin wound follows the finger as it is withdrawn to emerge at the inguinal wound where it grasps a suture inserted into the tunica vaginalis formed in Step 2. By pulling on the suture the testicle is pulled through the septum to the opposite side of the scrotum, where it is easily fixed by a few stitches.

Step 5.—Close the wound as in a Bassini operation, but instead of dislocating the cord, sew the conjoined tendon and Poupart's ligament together above, *i.e.*, superficial to the cord.

FIG. 863.—Ombrédanne's operation. (*Ombrédanne.*)

(B) Where it is impossible to get the requisite lengthening of the cord by the means described in Step 3, or when the testicle is intra-abdominal, the following measures suffice: Open the inguinal canal. Expose the testis; if necessary, "hook" it out of the abdominal cavity with the finger. The obstacle to the descent of the testicle is not the vas, but the spermatic vessels. Division of these does no harm to the testis. This was pointed out many years ago by Bennet, and agrees with the writer's experience. The testicle gets a sufficiency of nourishment through the artery of the vas. Doubly ligate and divide the spermatic vessels (Fig. 861). When this is done, it is easy to bring the testicle down into the scrotum.

CHAPTER LVII

HYDROCELE

Tapping a Hydrocele.—Clean the scrotum. Ascertain the position of the testicle by palpation; the patient's sensations aid, so does the translucency test. Place the left hand behind the scrotum and grasp it so as to render its anterior surface tense. Choose a point on the lower anterior surface free from veins and at this place thrust a trocar and cannula upwards and backwards to a depth of about one inch. Avoid thrusting towards the testicle. Withdraw the trocar and let the fluid escape through the cannula, keeping up pressure with the left hand. When the fluid is all evacuated withdraw the cannula. Dress the puncture with collodion or leave it to the care of nature which is usually equally good.

Radical Cure of Hydrocele.—I. *Injection Method.*—A. *Iodine Injection.*—Tap the hydrocele completely. Inject through the cannula about half an ounce of tincture of iodine. Withdraw the cannula. Rub the scrotum gently between the hands to insure even distribution of the iodine throughout the sac. Within twenty-four to thirty-six hours there is much swelling and pain in the scrotum but this soon subsides. After two or three weeks recovery ensues though a suspensory bandage is often required for some time.

B. *Carbolic Acid Injection.*—Tap and inject about ten drops of liquefied carbolic acid in the same manner as with iodine. It is difficult to inject through the cannula such a small quantity of liquid, hence the following method is better. By tapping withdraw most but not all of the liquid. Charge a hypodermic syringe with the carbolic acid. Puncture the hydrocele with the hypodermic needle until the needle touches the cannula, thus making sure that its point is really inside the sac. Permit the rest of the hydrocele fluid to escape through the cannula. Withdraw the cannula. Discharge the hypodermic syringe and withdraw it. The results of injecting carbolic acid are as good and less painful than when iodine is used.

II. *Incision.*—Volkman's operation. Make an incision, not less than 1½ inches long, into the sac. Suture the wound in the sac to the skin. Drain with tube or gauze. Apply dressings.

III. *Excision.*—Bergmann's operation. Through the skin make an incision extending from near the upper to near the lower end of the hydrocele. Expose the sac and by blunt and sharp dissection separate it from its coverings until its connections with the testicle are reached. Open the sac and trim it off close to the testicle. Attend to hemostasis. Close the wound with or without drainage. In scrotal wounds the writer usually inserts a *very few* interrupted

sutures between which it is easy for fluids to escape. Apply dressings and support the scrotum.

IV. *Eversion of Hydrocele Sac.*—Jaboulay's operation. Make an incision into the hydrocele. Bring the testicle out through the wound. Ligate and divide the gubernaculum testis. Fold the two sides of the divided sac behind the testicle and fix them there by a few sutures, one of which must interest the superficial tissues of the cord. Reduce the testicle. Close the scrotal wound by a few sutures (Fig. 864). This is a very satisfactory, easy and rapid operation.

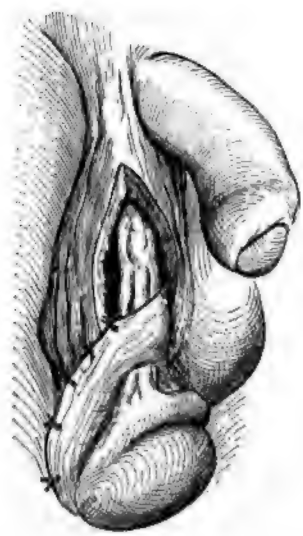


FIG. 864.—Jaboulay's operation. (*Duval.*)

Hydrocele of the Cord.—A. Small hydroceles or cysts of the cord. Expose the sac by an incision almost as long as itself. Pick up the upper end of the sac in the fingers and remove it if possible unbroken by gauze dissection.* Close the wound.

B. Hydrocele of larger size than the preceding.

(*a*) Incise and drain.

(*b*) Excise most of the sac wall.

(*c*) Eversion method. Incise. Turn the walls of the sac back and fix with sutures on the other side of the cord.

* Gauze dissection. Blunt dissection may be carried out with instruments or with the fingers. If a "sponge" or "wipe" of gauze is used over the tips of the finger the dissection is more satisfactory. This constitutes gauze dissection.

CHAPTER LVIII

VARICOCELE

Open Operation.—*Step* 1.—Make an incision parallel to and directly over the cord. The incision should be 1 to 1½ inches long and its upper end correspond to the external abdominal ring. Layer by layer divide the tissues until the cord is exposed.

Step 2.—Pick up the whole cord and isolate it from the external abdominal ring to the testicle. This is easy. Recognize the vas which feels like whipcord. Separate the vas and with it a very few veins, from the rest of the structures forming the cord and hold it aside.

Step 3.—Apply a crushing forceps near the external abdominal ring to the mass of veins to be removed. Similarly apply a crushing forceps or clamp to the same mass of veins near the testicle. Remove the crushing clamps. Tie catgut ligatures round the veins in the grooves left by the clamps. Cut away the veins between the ligatures leaving sufficient stump to prevent slipping of the ligatures. The only objects in using the crushing clamps are to provide a groove in which the ligatures can lie and to permit the use of a finer thread than would otherwise be necessary.

Step 4.—Bring the two venous stumps together and keep them together by a stitch or by tying the upper to the lower ligature.

Step 5.—Close the wound with or without drainage.

Remarks.—The incision is made at the level of the external abdominal ring because at this place (*a*) it is very easy to isolate the cord, (*b*) it is very easy to apply dressings after the operation.

On recovery, a suspensory bandage ought to be worn for some months. The junior surgeon may be warned that a hard swelling about the testicle usually persists for a few weeks after healing which may alarm the patient unless he is warned of the possibility before hand.

R. Frank's Operation ("Zent. f. Chir., iv, April, 1914).—Frank avoids ligation and resection of the veins with consequent fibrous degeneration of the parenchyma of the testicle.

Expose the fascia of the external oblique and the external inguinal ring exactly as in an operation for hernia. Strengthen the external inguinal ring with a stout stitch. Do *not* divide the fascia propria or the tunica vaginalis. Pull the testicle up out of the scrotum to the bottom of which it is attached by the gubernaculum. Divide the gubernaculum between forceps; ligate the scrotal stump but leave the forceps attached to the testicular stump. From the aponeurosis of the external oblique reflect downwards a flap (pedicle at the

external ring) 5 cm. (2 in.) long and 2–3 cm. (3/4–1 1/4 in.) wide. Suture the distal end of the aponeurotic flap to the testicular stump of the gubernaculum

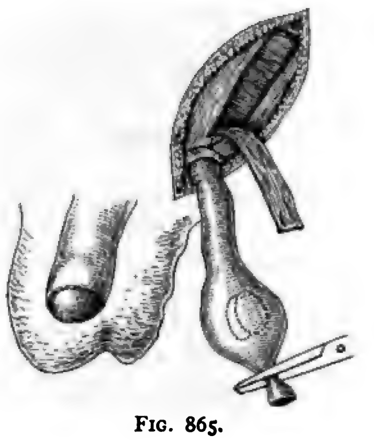


FIG. 865.

(Fig. 865). The length of the fascial flap must be sufficient to support the testicle in its physiological position just under the root of the penis. Reduce the testicle into the scrotum. Close the wound. The testicle now lies upside down in the scrotum.

PART V.—THE SPINE

CHAPTER LIX

OPERATIONS ON THE SPINE

It is important to recognize certain easily remembered relations which exist between the spinal cord and the spinous processes. These relations are thus described by Chipault: (Fig. 866.)

(*a*) The terminal cul-de-sac of the dura mater corresponds to the fifth lumbar interspinous space.

(*b*) The inferior limit of the spinal cord is situated in men at the level of the first, in women, of the second, in infants, of the third, lumbar spinous process.

(*c*) The cervical segment of the cord terminates at the level of the sixth cervical interspinous space; the dorsal, at the ninth dorsal; the lumbar, at the inferior border of the twelfth dorsal spine; the sacral segment ends at the superior border of the first lumbar spine.

(*d*) The relations of the summits of the spinous processes to the nerve roots may be expressed by a simple formula which, while not mathematically correct, is sufficiently so to act as a guide in surgical intervention.

For adults the formula is: In the cervical region to find the nerve which emerges at the level of the individual spinous process, add the numeral one to the number of the process, *e.g.*, it is the third cervical root which emerges opposite the second spinous process. In the superior dorsal region add the numeral two to the number of the process. From the sixth to the eleventh dorsal processes add the numeral three. The inferior part of the eleventh dorsal spinous process and the subjacent interspace correspond to the origin of the sacral nerves.

For children under the age of six or seven years the following modification of the formula holds good: In the superior dorsal region (from the first to the fourth apophysis) add three to the number of the spinous process to obtain the number of the corresponding nerve root; in the mid-dorsal region (fifth to ninth apophyses) add the numeral four.

LUMBAR PUNCTURE

Lumbar puncture is the operation by which the lumbo-sacral cerebrospinal cistern is tapped.

Objects of the operation. (*a*) Diagnostic: Observation of the tension, the chemical composition, the freezing point, the cellular composition, the bacteriology of the fluid and the permeability of the meninges to chemical substances

introduced into the blood. (*b*) Therapeutic: Relief of cerebro-spinal tension. (*c*) A step in the production of spinal anesthesia.

One must remember that there is no means of knowing whether the fluid obtained by puncture in any individual case is from the subarachnoid or the subdural space (Ballance).

The commonest site for the puncture is between fourth and fifth lumbar vertebræ, though Chipault thinks the lumbo-sacral space better as it is larger, surrounded by good landmarks and is opposite the terminal enlargement of the dural sheath: Puncture in fourth lumbar interspace.

It will be most convenient to describe the operation as performed for the production of spinal anesthesia.

Step 1.—Seat the patient with his legs and arms hanging in front and body bent well forwards. Clean the whole lower part of the back. Palpate the crest of the iliac bones; note their high points; join these points by a line. This line bisects the fourth lumbar space (Figs. 867, 868). Place and keep a finger on the point of the fourth lumbar spine.

Step 2.—Take a hollow needle about 3 inches long and about 1/32 inch (1 mm.) in diameter. Probably Dawbarn's is the best needle. Introduce the needle about 3/4 inch from the middle line and slightly below the spinous process. Push the needle slowly and steadily forwards and slightly inwards until the cerebro-spinal fluid escapes drop by drop. If the operation is performed for diagnosis or relief of tension collect the fluid in sterile test-tube. In children the needle must usually penetrate 1 to 1¼ inches, in adults 1½ to 2½ inches or more.

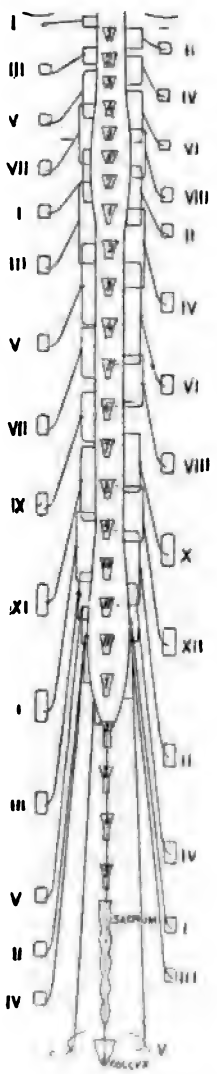


FIG. 866.—Relation between spinal cord and spinous processes. (*Poirier and Charpy.*)

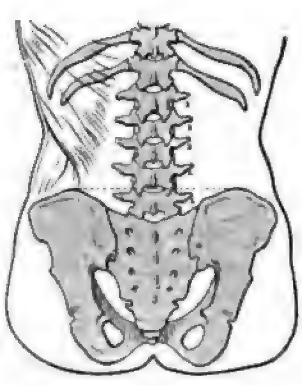


FIG. 867.—Spinal puncture. (*Marion.*)

Step 3.—As soon as the liquid begins to escape fix a hypodermic syringe to

the needle. The syringe should contain the sterilized powder to be injected (tropacocain; stovain; novocain). Slowly withdraw the piston of the syringe and thus draw cerebro-spinal fluid into the syringe. As soon as the fluid has dissolved the powder reinject slowly. Remove the needle. Dress the puncture wound with collodion. The operation may be performed with the patient in the lateral posture, lying down with the back thoroughly flexed.

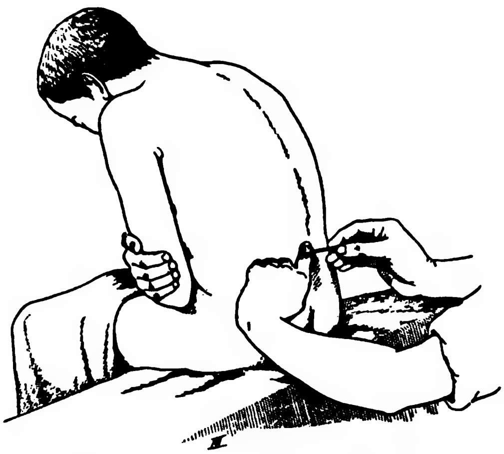


FIG. 868.—Spinal puncture. (*Marion.*)

SPINAL MENINGITIS

The operative treatment of spinal meningitis is in its infancy. A case reported by Kümmel ("Archiv für klin. Chir.," lxxvii, 938) gives hope for the future. A sacral tumor had been removed from a woman, aged twenty-seven; a fistula resulted and became infected; an extensive pelvic phlegmon formed; the patient became very restless and stupid, later comatose. Pulse 160. Temp. 105°. Cerebro-spinal meningitis was clearly present. By lumbar puncture there was drawn off cloudy purulent fluid which was under pressure. In spite of the desperate condition of the patient, the spinal canal was opened from the fistula up to the second lumbar vertebra; bad-smelling pus escaped; the discolored dura was widely opened; the arachnoid was injected and infiltrated with pus.

The patient regained consciousness, headache disappeared, vomiting ceased, spinal rigidity almost vanished. Owing to extreme weakness the patient died within forty-eight hours. The autopsy showed extensive suppurative cerebro-spinal meningitis; pelvic phlegmon and peritonitis; pericarditis. This case, in spite of its fatal outcome, is encouraging.

Murphy formulates the indications for operative intervention in acute meningitis as follows:

"1. Lumbar spinal puncture for the diagnosis as well as for the relief of cerebro-spinal tension. Large quantities of fluid may be withdrawn at in-

dividual sittings in this way, and the sittings may be as frequent as the symptoms of cerebral pressure recur. A cannula with a double opening at its lower end may be substituted for the needle in cases of rapidly recurring cases of hyperpressure. This must be very cautiously protected against the entrance of air and micro-organisms.

"2. Continuous drainage of the spinal canal with secondary drainage of the ventricles may be established by a single laminectomy with the insertion of a very small tube. This, however, will be rarely indicated if the cannula is used judiciously and to its best purpose.

"3. Ventricular drainage, transoccipital, can be made through a musculocutaneous flap with a trephine opening in the occipital bone to the right or left of the median line, an inch posterior to the foramen magnum. The dura may then be excised, the bony opening enlarged, if necessary, with bone-forceps, the velum exposed, opened if indicated, or the tube may be inserted in the subarachnoid space without opening the velum. This can be utilized in connection with spinal puncture or laminectomy.

"4. Transparietal ventricular drainage can be established by following the description given in the average work on surgery for the insertion of the tube into the lateral ventricles. A small trephine opening is all that is necessary for this procedure. It is an operation that will be rarely undertaken, as lateral ventricular is the least common of the meningeal infections. The duration of the drainage is governed by the general surgical principles of drainage. I prefer rubber to the metallic type of drain."

Operation for Acute Lepto-meningitis.—*Drainage and Spinal Irrigation.* —Place the patient in a position with maximum flexion of the lumbo-sacral region.

Step 1.—Make a three-inch longitudinal incision on *each* side of the sacrum, following the lines of the postero-external tubercles. Unite the lower ends of the incision by a curved transverse cut at the level of the last sacral tubercles. Reflect upwards the U-shaped flap until the sacral foramina are exposed.

Step 2.—With bone-forceps divide the sacral laminæ from below upwards until the dura is exposed at the third body. This portion of the dura forms the lower boundary of sacral cerebro-spinal cistern. Attend to hemostasis.

Step 3.—Make a small longitudinal incision through the dura. Permit the escape of enough fluid to relieve tension. Close the dural wound with a hemostat. Temporarily cover the wound with dressings.

Step 4.—Make an incision parallel to and below the occipital ridges ***on one side*** down to the bone. From the inner end of this incision make a median cut downwards to within ½ inch of the foramen magnum. Reflect the soft parts. Open the skull near the middle line over one cerebellar fossa.

Step 5.—Make a small opening through the dura into the cerebellar cistern. Introduce a blunt cannula, such as is used in the intravenous infusion of salt solution. Attach an irrigator charged with salt solution to the cannula.

Step 6.—Remove the forceps from the dural opening at the sacrum. Permit salt solution to flow through the cannula into the subdural space, through

the spine and out through the sacral wound. To demonstrate that the salt solution introduced above is escaping below Murphy suggests coloring it with carmine.

Step 7.—Insert rubber drainage-tubes into both the upper and lower openings. Close the wounds around the tubes. Regulate the cerebro-spinal tension by clamps applied to the tubes.

Murphy, who has systematized the above operation, writes: "The irrigation may not be needed, as a simple drainage with relief of pressure or pus tension is often all that is needed to conduct to a cure. It is the tension that favors absorption and tissue necrosis, and tiding over the primary acute pressure of the products of infection is life-saving."

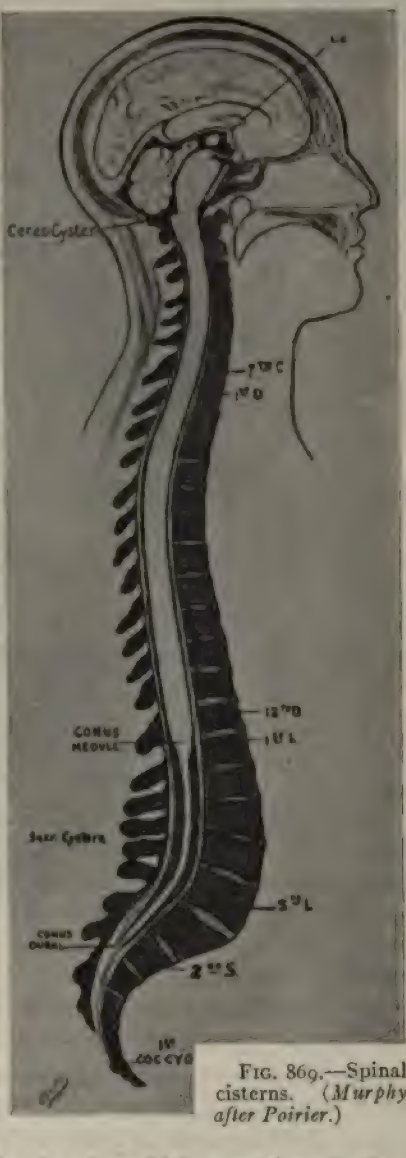


FIG. 869.—Spinal cisterns. (*Murphy after Poirier.*)

LAMINECTOMY

Laminectomy is the operative means by which the spinal canal is opened for exploratory or therapeutic purposes.

Method A.—*Step* 1.—Make a vertical median incision over the spinous processes. This cut reaches directly to the spinous processes, and is at least four inches in length.

Step 2.—On one side of the spine separate by sharp and blunt dissection the muscles from the side of the spinous processes and from the back of the laminæ of the vertebræ. Bleeding is usually severe. Quickly pick up the bleeding vessels with forceps and pack the wound with gauze wrung out of very hot water. Separate the muscles on the opposite side in the same way.

Step 3.—Choose the point at which to enter the spinal canal. Divide the interspinous ligament. Cut away the spinous processes with bone-cutting forceps. Proceed to the division of the laminæ for which several methods are available: (*a*) Apply an osteotome to the lower edge of the lamina and with blows of a mallet drive it through the bone. It is important to keep the long axis of the osteotome parallel to the plane of the bone lest the instrument pene-

trate and injure the contents of the canal. It is also important to have the bone incision at right angles to the lamina, otherwise the instrument may cut its way into the pedicle of the vertebra and much time be lost (Fig. 870). Having divided one lamina divide the lamina on the opposite side of the same vertebra and remove the bone. The laminæ of the vertebræ above and below may be divided as required with osteotome or with forceps.

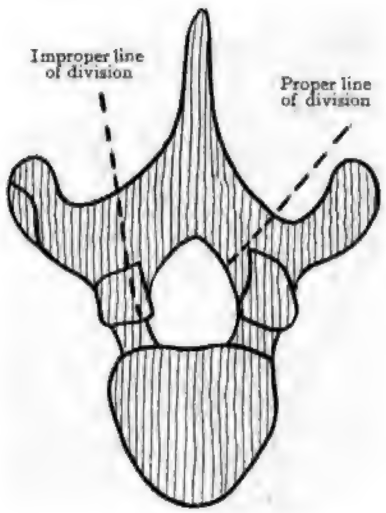


Fig. 870.

(*b*) Perforate a lamina with Doyen burr or with a trephine and complete its division with forceps (Keen's; "De Vilbiss," etc.).

(*c*) Divide the laminæ with a saw. (Hay's, "MacEwen's, Doyen's.")

Step 4.—Inspect carefully the contents of the spinal canal. Examine the anterior as well as the posterior surface of the cord. The cord may be gently pulled to one side without damage resulting. Note the condition of the posterior surface of the vertebral bodies.

Carry out any therapeutic measures which may be indicated. If it seems necessary to open the dura mater, do so, and close the opening with fine catgut sutures. Having completed the exploration or whatever operative measures may have been necessary, close the external wound by deep and superficial sutures, with or without drainage. Generally drainage during the first twenty-four hours is advisable. Apply the usual dressings and carry out subsequent treatment on the ordinary principles of surgery.

Method B.—Frazier's Method.—To increase insurance against infection and to arrest promptly the flow of cerebro-spinal fluid when the meninges have been opened Frazier divides the skin, fascia and muscles in different planes.

Step 1.—Reflect a skin flap, A B C D (Fig. 871), so as to expose the desired area.

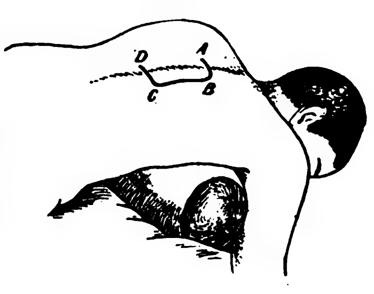


Fig. 871.

Step 2.—Make a vertical incision through the aponeurosis a little to one side of the median line and by reflecting the aponeurosis slightly from the deeper structures gain access to the muscles on each side of the spinous processes.

Step. 3.—Separate the muscles from the spinous processes and laminæ in the usual manner.

In closing the wound suture the different structures separately.

Method C.—Urban's Osteoplastic Method.—Make a **U**-shaped incision around the area of spine to be attacked. Through the vertical limbs of the **U** expose and divide the vertebral laminæ with chisel, saw, or forceps. Divide the interspinous ligament opposite the transverse part of the **U** cut. Expose the spinal canal by reflecting the **U**-shaped flap which contains, besides the skin and soft structures of the back, the spinous processes and part of the vertebral laminæ. (Fig. 872.) The rest of the operation is the same as in Method A.

FIG. 872.—Osteoplastic laminectomy. (*Urban, Archiv. für Klin. Chir.*)
a, Divided laminæ; b, post. wall of spinal canal reflected in flaps; c, cord.

Method D.—Abbé's Osteoplastic Method.—Make an incision through the soft parts about ½ inch to the side of the spinous processes. Expose one side of the spinous processes. With a chisel or osteotome divide the spinous processes near the laminæ. Turn the spines back along with the softs parts as a flap on the other side of the wound. Proceed with the laminectomy.

Method E.—Röpke's Temporary Laminectomy.—("Zentralblatt für Chir.," 1910, No. 33.)

Step 1.—Make a longitudinal incision over the spinous process of the selected

vertebræ. Separate the soft parts on each side from these processes and down to their bases. Remove each spinous process by cutting it at its base with a bone forceps.

Step 2.—With a wide chisel applied to the osseous wound cut off a slice of each lamina (Fig. 873) and retract these mobilized portions of laminæ along with the soft parts.

Step 3.—With a chisel or rongeur forceps excise the remaining portions of the laminæ. This gives free access to the spinal cord. Röpke in one case was able to remove two tumors from the sides of the cord and one from inside the cord itself.

Step 4.—After completing the operation on the cord and suturing the dura, replace the bone-periosteal flaps and close the wound with sutures.

To the author it seems that Röpke's operation will prove useful in cases of tumor of the cord and where division of the posterior nerve roots is indicated (Foerster's operation).

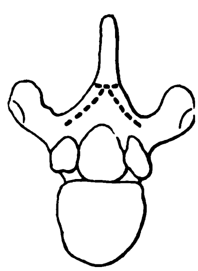


FIG. 873.—Röpke's method.

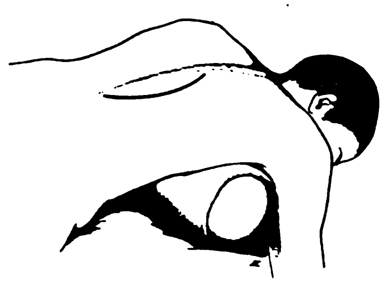


FIG. 874.—Osteoplastic laminectomy. (*Marion.*)

Method F.—Osteoplastic Method of Cavicchia and Durante.—This method, very similar to Abbé's is most highly recommended by Marion.

Step 1.—Make a slightly curved incision (Fig. 874) to outline a skin flap which when reflected will expose the region to be attacked. As in craniectomy it is necessary to open the spine widely to avoid missing the lesion present. A minimum of four arches ought to be opened except in cases of localized osseous lesions; hence a large skin incision is necessary." (Marion.)

Step 2.—Leaving the supra- and interspinous ligaments intact, separate the soft parts on each side from the spinous processes and laminæ. Retract the soft parts. With the chisel as in Abbé's operation divide the bases of the spines or do the same thing by means of special forceps (Fig. 875). Retract the line of mobilized spinous processes which remain attached to each other and to the body by the supra- and interspinous ligaments.

Step. 3.—As in Method A. When wound is closed the chain of spinous processes is left in place and is believed to give support to the back.

To the author it seems that the simplest manner of opening the spine is the best. The loss of the laminæ of four vertebræ does not seem to appreciably lessen the stability of the spine.

TUBERCULOUS PARAPLEGIA

.uberculous lesion situated in the body of a vertebra (usually lower or upper lumbar) may spread backwards and form a tuberculoma which on the *front* of the cord. The cord is usually bent and flattened but ɔng time there may be no trophic or degenerative changes in the cord.

FIG. 875.—Division of spinous processes. (*Marion.*)

se favorable for operation the disease is practically an extra dural tumor posterior surface of the vertebral body and hence the early paraplegic ıms are purely motor. Operation is indicated *before* degeneration of the ecomes established and after proper treatment by hygiene and im- :ation has failed. According to Gowers paralysis due to vertebral caries nost favorable of all types of paralysis.

Operative Treatment.

Step 1.—Open the spine by laminectomy. Do *not* open the meninges.

Step 2.—Displace the cord to one side. Expose the granuloma and thoroughly remove it with the curette. Dry the bone cavity carefully and fill it with a Mosetig-Moorhof bone plug.

[Iodoform, 60; spermaceti and oleum sesami, āā, 40; heated slowly to 100° C. in a flask on a water-bath; kept at this temperature for fifteen minutes, then removed and allowed to cool and solidify, while shaken constantly. Before using, melt and heat to 50° C. in a thermostat.]

If the wound heals without suppuration and operation has not been too long delayed, the paraplegia rapidly disappears.

Harte ("Trans. Am. Surg. Assoc.," 1905) has collected records of ninety-two operations for spinal tumors with a total mortality of 47 per cent.; the mortality due to the operation was, however, only 28 per cent. Even when a cure could not be obtained relief from pain was almost always secured. The large number of sarcomata removed and the striking absence of recurrence exhibited (seventeen out of thirty-seven) makes it probable either that there was a mistake in the histologic diagnosis or that sarcomata in this region are of comparative benignity.

In some of Harte's cases the symptoms of tumor were due to meningeal thickenings or adhesions. In the discussion of Harte's paper J. C. Munro stated: "In a number of cases that I have had—cases of syringomyelia and of chronic fracture—I have found that which at one time was denied by pathologists, a definite, localized collection of clear fluid in the subarachnoid space which produces by its presence more or less complete paralysis. By opening this small sac of fluid the symptoms may be absolutely relieved." These remarks of Munro's are quoted here because they bear out remarkably some observations of F. Krause (Proceedings, "German Surg. Soc.," 1907). Krause has opened the spinal canal twenty times for tumor-like symptoms, and has found tense subdural collections of fluid eight times. On section of the dura the fluid forced itself out and the arachnoid protruded in bladder-like manner through the dural wound. Adhesions existed between the dura and the pia. The disease is a local collection of fluid in the arachnoid and has been named meningitis serosa spinalis. The results obtained from evacuation of the fluid and closure of the wound have been good.

In operating for tumors one must remember the tendency to locate the tumors at a lower level than that at which they actually exist and that therefore, if no growth is found on opening the spine, one should remove the laminæ of one or two higher vertebræ.

TUMOR OF THE SPINAL MENINGES

Expose the spinal canal by Method A. If the tumor is external to the meninges extirpate it, being careful to avoid injury to the nerve roots. If any nerve leaving the cord is divided, it should, if possible, be immediately

reunited by suture. The posterior surface of the meninges is generally separated from the bone by a collection of fat containing many veins; thus hemorrhage may be troublesome, but this can be readily stopped by packing with strips of gauze wrung out of very hot water. When the tumor is inside the dura, that membrane must be divided, the limits of the growth defined, and its removal effected by careful blunt dissection. After attending to hemostasis the wounded dura may be sutured or not, according to indications.

Tumors of the cord itself are not amenable to surgical treatment.

INJURIES TO THE SPINE

It is extremely difficult to lay down precise rules for guidance as to when and when not to operate in injuries of the spine and spinal cord. J. B. Murphy has formulated certain guiding principles, of which an abstract is here given:

A. Paralysis from contusion may be due to "traumatic zonal inflammation," may have no initial symptoms and may only develop days or even weeks after the injury. Such cases are more liable to be cured without than with surgical intervention.

B. When *immediately* after the injury there is *uniformly transverse, complete* paralysis of motion and sensation operation is useless, as the cord is completely divided and regeneration is impossible.

C. Fracture of the spine is present, but there is no great displacement. Paralysis appears hours, days or weeks after the injury. The paralysis is *not* complete and annular of both motion and sensation. It is impossible to diagnose whether the cord lesion is due to contusion or to pressure. Murphy advises strongly against operation.

D. If under the above circumstances (C) there is marked displacement it is proper to diagnose compression, and immediate operation is indicated.

E. Fracture of the spine is present below the twelfth dorsal vertebra. The rules given above no longer apply. At the twelfth dorsal vertebra the spinal cord ends and the cauda equina begins.

"The cauda equina, which begins here, is made up of essentially peripheral nerve fasciculi, and not of spinal cord fasciculi, as the axones of the motor root in this portion have their ganglion trophic cells above this level in the conus, and the motor axones in the cauda are covered with the sheath of Schwann, or neurilemma. They therefore degenerate after division, and have the power of regenerating, the same as peripheral motor axones. The sensory neurones of the posterior roots of the cauda have their ganglion cells just inside the sacral and lumbar foramina. Their proximal axones, which run through the cauda to the spinal cord are medullated, and have a sheath of Schwann. They are capable of regenerating, at least up to the posterior commissures, and from clinical observation, we believe, can again functionally contact with the posterior horn of gray matter. In other words both the motor and sensory neurones in the cauda outside of the cord are histologically capable of regeneration under favorable conditions; that is, after accurate suture and exact approximation of the ends of the divided caudal fasciculi under aseptic conditions."

Every case of fracture of or injury to the spine in the lumbar region accompanied by paraplegia demands operation. Causes of compression must be removed; divided fasciculi must be united by suture. "It is easy to determine which are the right and left fasciculi by a mild faradic current up to the seventh day after the injury."

F. In cases of bullet wound of the spine, when the bullet is shown by the X-rays to be inside the spinal canal, operation is demanded. Other cases of bullet wounds of the spine should be treated by the rules already laid down.

The principles or rules which have been outlined in the preceding paragraphs are given by Murphy in his classical monograph ("Surg., Gyn. and Obstetrics," April, 1907) and are the outcome of large experience and untiring study. It would be improper, however, to omit giving the opinions of some other experienced and judicious surgeons. Chipault advises early operation, except when functional disturbance is very slight or shock is very severe. Reduction by extension and local pressure is condemned, as such manœuvres are very liable to press fragments of bone into the cord and increase the damage immensely.

A. J. McCosh advocates early operation before there is time for secondary degenerations to become established. He has seen good follow in cases where the symptoms pointed to total transverse lesions. Mixter and Chase have pointed out that in spite of the absence of conduction, normal fibres may pass through the crushed portion of the cord. Kocher writes, "If one has had Munro's experience, that out of thirty cases of injury to the upper dorsal and the cervical vertebræ one only within ten years lived and had partial restoration of function, while in the same period of time operative treatment resulted in three complete cures, then one will tend to advise operation in every case. The cases must be very carefully examined: if the temperature sinks low (as is often the case in high lesions of the cord) no operation is proper. Munro lost all the patients on whom he operated for acute crushing of the cervical cord. It remains undoubtedly true that we must diagnose irreparable total transverse destruction of the cord in the great majority of patients who exhibit sudden and complete loss of motion and sensation with immediate and total loss of the tendon reflexes; but it is also true that if the transverse lesion is not total then remnants of sensation are present from the first or appear in a few hours or days."

Jacobson ("Operations of Surg.," ii, 1091 ed. 1908) is averse to any surgical interference in cases of fractured spine, owing to the amount of damage to the cord being usually, from the first, irreparable. Thorburn has the same opinion as Jacobson regarding fractures above the level of the first lumbar vertebra; regarding fractures below this level, he advocates surgical interference on the following grounds:

"1. We may here expect a regeneration of the nerve roots, the physiological evidence being strongly in favor of such regeneration, and not against it as in the case of the cord.

"2. The absence of spontaneous recovery in such cases in itself indicates the presence of a mechanical obstacle, such as permanent compression by bone, blood-clot, or cicatrix, otherwise we should expect the roots of the cauda equina to recover as other peripheral nerves after severe injuries."

Burrell ("Trans. Am. Surg. Assoc.," 1915) studied the records of cases of spinal fracture treated in the Boston City Hospital and came to the following conclusions:

"1. That fractures of the spine may well be divided into two classes: first, fractures of the spine with injury to the cord; and, second, fractures of the spine without injury to the cord.

"2. That it is not best to decide what the treatment of an individual case of fracture of the spine should be from the statistics, because the lesion varies so widely.

"3. That in many cases of fracture of the spine it is impossible to primarily state whether the cord is crushed or pressed upon by bone, blood, or exudate, except by an open operation.

"4. That only by the persistence of total loss of reflexes, complete insensibility to touch and pain, and motor paralysis below the level of the lesion can total transverse destruction of the cord be diagnosticated.

"5. That if pressure on the cord is allowed to remain for many hours, irreparable damage to the cord may take place.

"6. That unless it is perfectly clear that the cord is irremediably damaged, an open operation to establish the condition of the cord and to relieve pressure is imperative as soon as surgical shock has been recovered from.

"7. That in certain cases of fracture of the spine, when the cord is not injured, but is liable to injury from displacement of the fragments of a vertebra, rectification of the deformity and fixation of the spine may be used.

"8. That if the cord is crushed, no matter what treatment is adopted, there will, of necessity, be a high rate of mortality."

Open the spinal canal by Method A. Remove all blood-clot and severely damaged tissues. Stop bleeding. Examine thoroughly the posterior surface of the cord. Examine the anterior wall of the spinal canal. If there are displacements of bone in this location, interfering with the cord or lessening the calibre of the spinal canal, try to reduce such by manipulations under the guidance of the eye and finger. If manipulations fail, cut away such pieces of bone as threaten the integrity of the cord or jut into the canal. This may be done with the chisel or rongeur forceps. The amount of bone removed may be considerable. Examine the cord once more. If it does not pulsate and presents a distended and bluish appearance, open the dura and clear out the blood-clot which will be found. If the cord is flabby and small, there are probably adhesions existing between the membranes and the cord or between the various nerve roots. This condition calls for the dura to be opened and the adhesions separated.

Any operation undertaken must be done thoroughly. The wound in the dura should be closed, unless this is contraindicated. The external wound

is sutured as usual, dressings applied, and the trunk immobilized. Harte and Stewart ("Trans. Am. Assoc.," xx) report the case of a woman twenty-six years of age who was shot at the level of the seventh dorsal vertebra. Operation showed that the spinal cord was completely severed, a gap of 3/4 inch existing between the segments. After removal of lacerated and fragmented tissues the cord was united by three chromicized catgut sutures. Sixteen months after operation "the patient voluntarily flexes the toes, flexes and extends the thighs, and rotates the hips. While sitting the extended leg can be raised from the floor; the patient can slide out of bed into her chair by her own efforts. . . . The bowels move every second day and are under perfect control, excepting the presence of diarrhœa."

SYRINGOMYELIA

J. B. Murphy ("Surg., Gyn., Obstetrics," April, 1907) writes:

"While neuropathologists disagree as to the origin of syringomyelia, their findings are uniformly the same. Examination of a cord, even before its section, reveals a bulging on the posterior half of the cord, which fluctuates on palpation. On section, one or several cavities are found extending upwards and downwards, either for a limited distance or through the entire cord up to the bulb, and occasionally involving the latter. Primarily the cavity is more commonly found in the cervical swelling of the cord. The cavity occupies, almost invariably, one or both posterior horns, just behind the commissure and close to the central canal. The latter is not necessarily dilated, and in some cases is so contracted that it is almost impermeable. Again, the syringomyelic cavity may communicate with the central canal and form one large cavity, impressing one that the condition might be a primary hydromyelia. The tube may be patent or may be subdivided by septa, either lengthwise or laterally, making single or multiple cavities. It may communicate with the fourth ventricle or end near it in subarachnoid space. The shape of the cavity is tubular or triangular, and it is lined with cylindrical epithelium similar to that of the central canal.

"It seems to us, from a theoretical standpoint, that this disease, at least in its circumscribed form, offers a field for surgical intervention. As soon as opportunity presents itself, I will perform a subdural drainage with an inabsorbable seton which will keep a permanent communication between the syringomyelic canal and subdural space, and insure an equalization of pressure, which should stop the advancement of the disease, even if it does not permit restoration of function in some of the compressed ganglion-cells and axones. This operation suggested by Murphy is along the lines of those successfully performed by Sutherland and by Ballance in the treatment of hydrocephalus."

SPASTICITY

Foerster's Operation.—*Operative Treatment of Spasticity and Athetosis. Division of posterior or sensory roots in spastic paraplegia and in the crisis of*

tabes. Frazier writes ("Surg., Gyn., Obstet.," Sept., 1910). If we admit that spasticity or spastic muscular contractures are reflex disturbances, unrestrained by cortical impulses, one way, if not the only way of controlling them, is to remove at least one link in the chain of the reflex arc. Naturally the motor portion of the arc, the anterior horns, the roots, or the peripheral nerves cannot be broken, otherwise the limb would be hopelessly paralyzed; for the same reason the sensory nerves, many of which are mixed nerves, must be left intact, so that by a process of exclusion there remain the sensory roots."

Stubborn cases of radiculitis causing various distressing symptoms may be suitable for Foerster's operation.

Division of the posterior roots was first suggested by Spiller in 1905 ("Journ. of Nervous and Mental Diseases," May, 1905) but Foerster seems to have pushed the matter more vigorously and reported five cases of his own in which Tietze operated. (Foerster, "Zeitschrift für Orthop. Chir.," xxii; Mittheil-

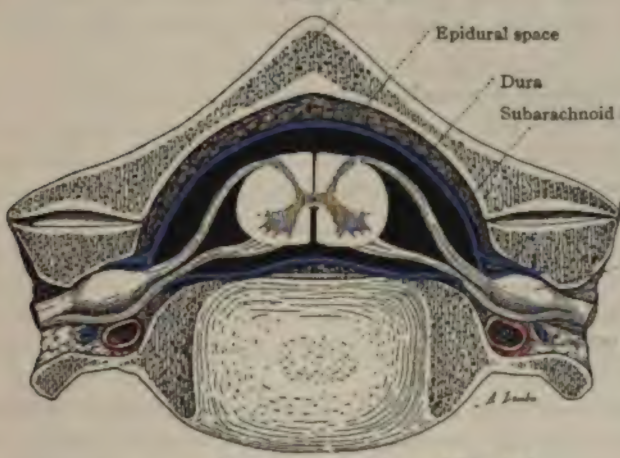


Fig. 876.—(*Poirier and Charpy.*)

ungen aus "d. Grenzgeb. d. Med. und Chir.," xx; Tietze, Mittheilungen aus "d. Grenzgeb. d. Med. und Chir.," xx.)

A number of different methods of operating have been devised by various surgeons. Tietze and others divide the operation into two stages: first, performing laminectomy and some days later opening the dura and completing the work. Undoubtedly a two-stage operation facilitates the finding of the posterior roots in that there is less blood to obscure the view, but bleeding can be well controlled by pressure with pads of hot gauze against the spinal muscles, and by packing narrow strips of gauze between the dura and the lateral portions of the vertebræ after the spinal canal has been opened. Danger from infection is distinctly less in a one-stage than in a two-stage operation. (For Frazier's method of exposing the cord see p. 760.) To distinguish the posterior roots it is necessary to have free exposure of the posterior surface of the cord; if blood

obscures the view it ought to be removed by gentle douching with warm salt solution (Fig. 876).

After the dura is opened attempts to remove blood by means of sponging are liable to do much damage to the delicate nerve structures exposed.

How many and which of the posterior roots ought to be divided?

Frazier writes: "It is known that the supply of each muscle or group of muscles is represented in most instances by three segments of the cord and by as many roots and, according to the observations of Sherrington, the cutaneous nerve supply of any given area is derived from at least three roots. Theoretically we plan to break the reflex arc of the muscles involved, by cutting off as many peripheral stimuli as possible; we should not, however, remove every source of sensory stimulation, otherwise we would substitute a condition of absolute anesthesia and flaccidity for one of spasticity. In selecting the roots to be sacrificed it is necessary obviously to remove at least two of the three possible sources of sensory stimulation, or, in other words, two of the three roots from which a given group of muscles derives its sensory supply. The following table gives the sensory distribution to the muscles of the lower extremities:

Flexors of the thigh, $L_1L_2L_3L_4L_5S_1$
Extensors of the thigh, $L_5S_1S_2$
Adductors of the thigh, $L_2L_3L_4(L_5)$
Abductors of the thigh, $L_5S_1S_2$
Exter. rotators of the thigh, $L_5S_1S_2$
Int. rotators of the thigh, $L_3L_4L_5S_1S_2$
Extensors of the leg, $L_2L_3L_4$
Flexors of the leg, $L_3S_1S_2$
Dorsal flexors, foot, $L_4L_3S_1$
Plantar flexors, foot, $L_5S_1S_2$

In considering an operation for spastic paraplegia there are seven roots to be considered, namely, the five lumbar and the first two sacral roots. According to Foerster's first dictum at least four roots should be sacrificed and he selected for the lower extremity the second, third, and fifth lumbar and the second sacral, leaving intact the first, the fourth lumbar, and the first sacral.

"The general rule has been not to remove more than two successive roots. If the results of some of the operations have been accurately recorded our views regarding the sensory distribution of the spinal roots may have to be revised. Thus Taylor in one case resected six successive roots, from the twelfth dorsal to the fifth lumbar inclusive, on one side with full retention of sensation, and in another case seven successive roots from the fourth cervical to the second dorsal inclusive, without loss of reflexes. This is absolutely at variance with our present conception of the distribution of the spinal roots and suggests the possibility of the operator having left some fibres undivided. The difficulty in separating the sensory from the motor roots may be attributed to the inadequate exposure of a unilateral opening.

"Whether or not it may be possible to resect a series of five, six, or seven

successive roots without permanent disturbance of sensation or reflexes in a given extremity, it is unquestionably true that the desired end may be attained, the spasticity relieved, by resecting four out of seven of the total number of roots supplying a given area. Thus in one of Foerster's cases, one of Gottstein's, and two of my own the spasticity was relieved by resection of three lumbar, or three lumbar and one sacral root.

"On the other hand, if too few roots are resected the results may not be as satisfactory. This was the case in one of Foerster's patients where he resected only the third and fifth lumbar and the second sacral, and in one of my own, where although four successive roots were resected—namely, the fifth, sixth, seventh and eighth cervical—the spasticity was only partially relieved. Therefore, at this juncture it is not possible to lay down any hard and fast rule, suffice it to say that for the lower extremity perfectly satisfactory results have been obtained after resection of the following combinations:

1. $L_2L_3L_5$,
2. $L_2L_3L_5S_2$, or
3. $L_2L_3L_5S_1$.

"For the upper extremity the following combination, $C_4C_5C_6C_7$, was wholly effective in one case (Taylor's third case) while $C_5C_6C_7C_8$ only partially so in another (Frazier's case).

"We may conclude from this that, until further observations are made, the fourth cervical should be included, with or without the eighth."

Immediately after operation pain and spasticity may apparently be increased, just as after amputation of the leg severe pains are experienced and thought to be in the foot which has been removed. Soon such distressing symptoms decrease and disappear. It is necessary, however, in cases of spasticity, to correct deformities which have become established and to institute well regulated muscular exercises.

Foerster's operation ought to be reserved for severe cases of spasticity and of the crisis of tabes.

The published results have been good and the death rate has not been very high considering the gravity of the procedure.

Hofman's Method of Performing Foerster's Operation.—Temporary Laminectomy. ("Zentralblatt für Chir.," 1910, No. 20.)

Step 1.—Make an incision of the desired length over the spinous processes of the vertebræ to be reflected, and separate the musculature by blunt dissection from the spinous processes and from the laminæ on both sides as far as the lateral processes. The sharp bleeding which comes from the muscles is easily controlled by gauze pressure. The periosteum has not been injured.

Step 2.—Divide the laminæ on each side by means of an osteotome held as horizontally as possible.

Step 3.—Divide, transversely, the interspinous ligament either above or below the series of vertebræ attacked, according as the bone flap is to be reflected downwards or upwards. After division of any remaining connections reflect the flap (consisting of periosteum, spinous processes, laminæ and inter-

spinous ligaments) upwards or downwards as may be desired. The dura is now at least partially exposed and can be fully exposed by nipping away some more bone with rongeur forceps. If the chisel is properly applied Hofman claims that injury to the dura or cord is hardly possible. This claim is in full accord with the experience of the late D. J. Hamilton who, in the postmortem room, similarly exposed innumerable spinal cords without injury to their structure.

Step 4.—Incise the dura longitudinally and divide the desired posterior spinal roots.

Step 5.—Close the dural wound by a continuous suture.

Step 6.—Replace the reflected bone flap. Suture the muscles and fascia over the spinous processes. Close the skin wound.

Hofman performed the above operation in one-half hour, which would have seemed totally incredible to the author had he not known of Hamilton's remarkably rapid work in the autopsy room, to which reference has already been made.

(Further information regarding Foerster's operation is to be found in the discussion before the German Surgical Association. "Zentralblatt für Chir.," 1910, No. 31; Codivilla, "Muenchner med. Woch.," lvii, p. 1438; Florcken, "Muenchner med. Woch.," lvii, p. 1441; Bierens de Haan, "Journal de Chir.," Sept., 1910. Discussion, Brit. J. Surg., II, Oct., 1914.)

Stöffel ("La Presse Med.," March 30, 1912) writes regarding the spastic contractures of cerebral hemiplegia or Little's disease "certain muscles and groups of muscles are particularly the site of these spasmodic contractures. (The gastrocnemii, the flexors of the knee, the adductors of the thigh, the pronators and flexors of the hand.) When these muscles are involved, they respond to stimulation with excessive force; their contraction is violent, exaggerated. They dominate and annihilate their antagonists, they completely upset the muscular equilibrium. * * * The power of voluntary muscular contraction is almost never absent, it is only impeded and masked by the spasm." Foerster's operation is entirely too serious to be considered except in very grave cases.

Stöffel considers that the motor nerves are like telephone cables and contain many filaments, each going without fail to its own muscular fibre or bunch of fibres. Thus any one muscle may be considered as composed of numerous individual muscles (the fibres) each supplied by its own nerve. If a proper number of the individual muscle fibres or bundles of fibres could be paralyzed by division of their nerve filaments, the rest of the muscle being left intact then there would be so much weakening of the muscle as a whole that it could not overpower its antagonists. Such division of nerve filaments may be accomplished at several points on the course of the motor nerve. "The simplest case is where one can expose and follow the nerve to its point of entry into the muscle, *e.g.*, at the upper extremity of the gastrocnemius. At this level the various branches of the nerve are separated and one can easily divide some of them." Where it is impossible to follow the nerve as above, *e.g.*, in the case of the quadriceps and the flexors of the knee, it is easy to expose the nerve, transfix it with a very fine tenotome and divide a very limited portion of it. "If we wish

to weaken the *pronator radii teres* we attack the median nerve in the middle of the arm. To weaken the tibiales anticus and posticus we expose the anterior and posterior tibial nerves and section part of their fibres." Stöffel's operation properly carried out "ought to fulfill a double aim to suppress the spastic contracture and to reestablish at once the function of the muscle which was contracted. The first object is easily attained by complete division of the motor nerve supply, but this completely suppresses the active function of the muscle as well as its contracture and so does not attain the second object of the opera-

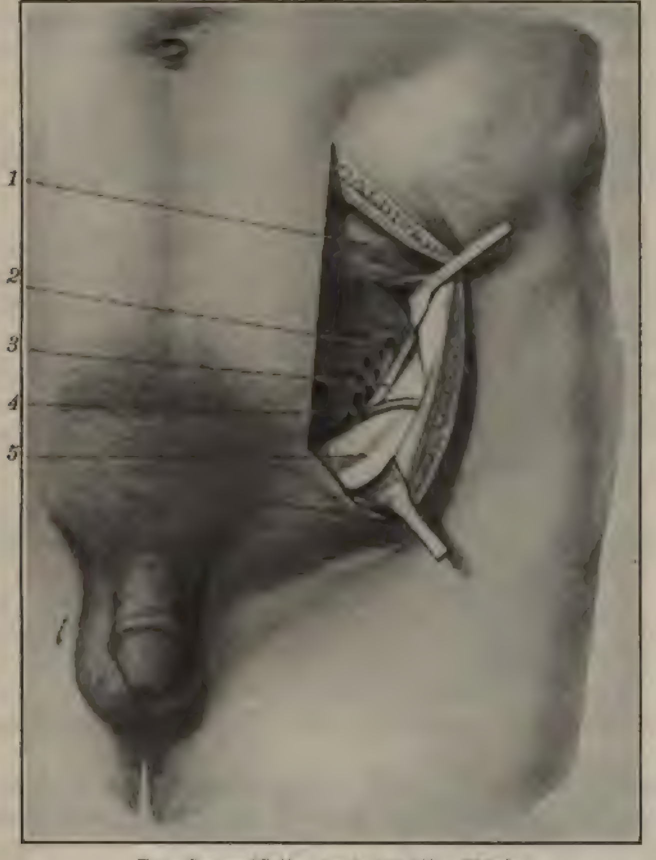


FIG. 877.—(*Selig, Arch. für klin. Chir.*)
1. Peritoneum pushed back. 2. Prevesical space containing connective tissue and fat. 3. Obturator nerve. 4. Anastomosis between deep epigastric and obturator veins. 5. Horizontal ramus of pubis.

tion. We ought to divide only part of the nerve supply. If we divide too little the contracture is not removed, if too much, function is destroyed. Can one determine exactly how much of the motor nerve ought to be divided to obtain the exact degree of energy desired in the muscle? To this question I answer affirmatively. By taking into consideration the degree of the contracture, the anatomy and physiology of the contracted muscles, the value of the synergic and of the antagonistic muscles, it is easy to determine how much of the nerve

ought to be divided. Practice naturally plays a great rôle in this estimation and as in any new method, one learns in every case. At first one divides too much or too little, but one soon acquires the necessary experience." After operation the antagonistic muscles should be strengthened by gymnastics, massage, electricity, etc. (For Jones' treatment of Little's Disease, see p. 1247.)

In spastic contracture of the adductors of the thigh R. Selig (Arch. f. Klin. Chir., ciii, 994) advocates division of the obturator nerve before its entrance into the obturator canal. The fact that the adductor magnus gains part of its nerve supply from the sciatic nerve explains why after section of the obturator nerve, while spastic contraction is prevented, active contraction remains possible. The obturator nerve arises from the second, third and fourth lumbar nerves, crosses the sacro-iliac joint and the internal iliac artery to find its way along the lateral wall of the true pelvis until it enters the obturator foramen. In its course it follows the lower margin of the horizontal ramus of the pubes a little below the innominate line. The nerve forms a thick palpable cord of easy access.

Exposure and Division of the Obturator Nerve.—Make a vertical incision about 3 inches in length along the border of the rectus muscle low down. Expose, but do not divide, the peritoneum and the transversalis fascia. By blunt dissection separate the peritoneum from the overlying structures in the lower part of the wound until the horizontal ramus of the pubis is reached. Pass the finger behind the horizontal ramus and palpate the obturator foramen. To the outer side of the foramen the cord-like nerve can be felt. Fig. 877 shows the relations of the nerve. Expose the nerve and divide it. Close the wound as in any abdominal operation.

SPINA BIFIDA

To understand the operative treatment of spina bifida and the limitations thereof, it is absolutely necessary to have clear notions as to its pathological anatomy. The usual surgical text-books rarely provide such notions, hence the author will try to describe, very briefly, the conditions which should influence operation.

A. **Meningocele.**—A defect of the posterior osseous wall of the spinal canal is present. The skin, spinal membranes, and cord are intact. There is a hernia of the dura through the osseous defect. Fluid in greater or less quantity is present in the dilated subdural space (Fig. 878).

B. **Meningocele.**—The conditions are the same as in A, except that the arachnoid is involved in the hernia and the collection of fluid is in the subarachnoid space (Fig. 879).

C. **Meningocele.**—A defect exists in the dura as well as in the bone. Through these defects there protrudes a hernia consisting of the arachnoid with fluid accumulated in the subarachnoid space. The skin, pia, and cord are intact.

D. **Myelo-cystocele** (Fig. 880).—There exists a defect in the posterior ›ous wall of the spinal canal and also in the corresponding portion of the a. The arachnoid and pia are intact. The central canal of the spinal 1 is highly distended by fluid, so that a hernia is formed having the arach-1 and pia as sac. The cord substance is thinly spread out over the inside he sac—so thinly that in places it is absent. The spreading out of the cord lue to the distention. As will be seen by reference to the diagram, nerve ts run forwards *in* the hernial sac. This is of importance to the operator.

E. **Myelocele.**—A defect exists in the skin, in the posterior osseous wall the spinal canal, and in the corresponding portions of the dura, arachnoid, 1 pia. The posterior surface of the cord itself is split or absent. The

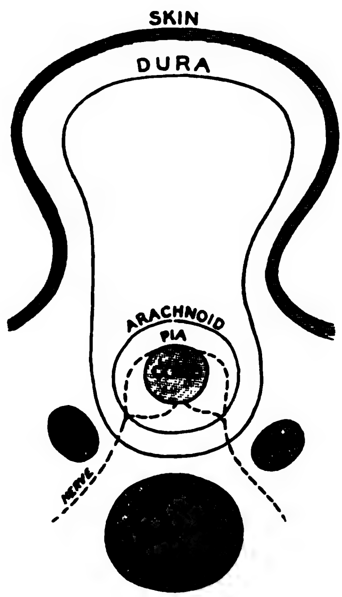


FIG. 878.—Meningocele A.

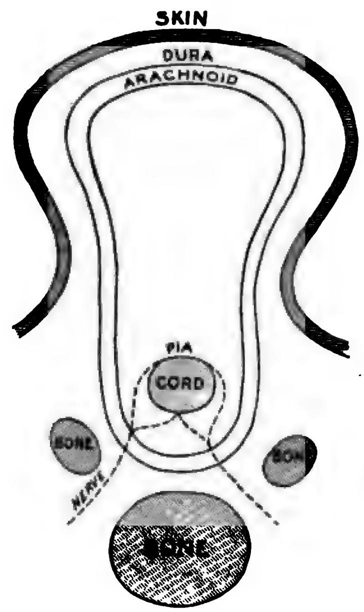


FIG. 879.—Meningocele B.

tral canal of the cord is open to the air (Fig. 881). Fluid collects between pia and arachnoid anterior to the cord, and gives rise to a spinal hernia. will be seen by referring to the diagram, skin is present only at the base the tumor; the hernial sac consists of pia mater with a covering of cord sub-nce. The nerve roots run from the cord forwards through the sac. Should :ollection of fluid form in the arachnoid instead of in front of it, then the ıchnoid will form part of the hernial sac and the nerve roots will run forwards the sac wall.

F. **Myelocele.**—This form is the same as E, except that there is no col-:tion of fluid (Fig. 882). The remnant of cord substance lies in a groove depression on the back and is continuous with the skin. The meninges e continuous with the subcutaneous tissues.

The differential diagnosis of myeloceles E and F is easy. They are inoperable.

The diagnosis between myelo-cystocele D and meningoceles A, B, and C is generally impossible, except perhaps, as Horsley has suggested, by applying the electric current and observing its effects. Myelo-cystoceles are more frequently accompanied by other deformities, *e.g.*, club-foot, exstrophy of the bladder, etc., than are meningoceles. The fact that the walls of a myelocystocele contain nerve substance, while those of meningoceles do not, makes positive differentiation between the two forms of spina bifida indispensable for scientific treatment. If we inject a solution of iodine (Morton's fluid)

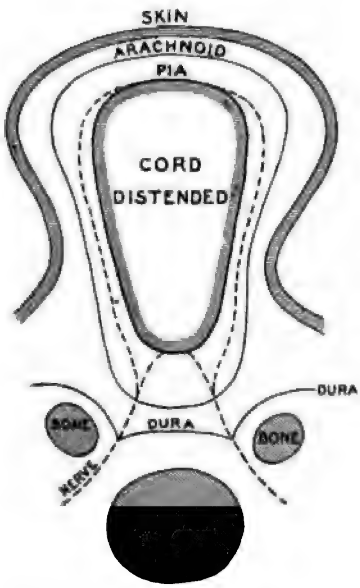


FIG. 880.—Myelo-cystocele.

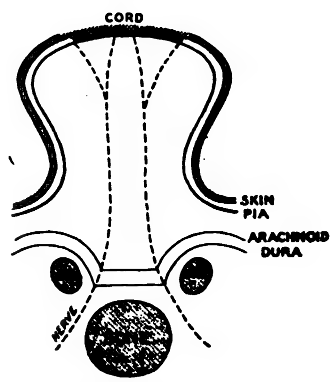


FIG. 881.—Myelocele E.

FIG. 882.—Myelocele F.

into the sac, we may be really throwing it into the central canal of the spinal cord. The injection of iodine has been, until recently, the favorite treatment for spina bifida, but in view of the facts related above one is compelled to believe it unscientific.

Operation is contraindicated in cases of myelocele; in cases of spina bifida accompanied by paralyses or contractures evidencing irreparable defects in the cord substance; in cases of severe hydrocephalus or of abdominal or vesical fistulæ—in all other cases operation is proper.

One must remember that the successful closure of a spina bifida may remove a safety valve from the cerebrospinal system, and that a persistent excess secretion of cerebrospinal fluid may lead to fatal hydrocephalus.

The Operation.—Step 1.—Make two skin-flaps from the base of the tumor, of sufficient size to cover the wound left after removal of the sac. These flaps should be made large rather than small, as it is easy to trim them to suit, before applying sutures.

Step 2.—Having exposed the sac by reflecting the skin-flaps, make an incision into it on one side. This incision should be made transversely and must not reach to the middle lines of the body (*i.e.*, to the apex of the tumor). The reason for these precautions is that most of the medullary tissue, if present, is situated in the middle line, and that the general course of any nerve roots is from the summit of the sac to the base, *i.e.*, parallel to the direction of the incision.

Step 3.—Explore the sac and observe whether nerves lie free in it (Fig. 879) or are enclosed in its walls (Fig. 878). If the nerves lie free in the sac, trace them to their point of origin in the medullary substance which forms part of the sac. Separate the medullary substance, and such of the sac as is united to it, from the rest of the sac and reduce it into the spinal canal. Remove the excess of sac. If the nerves lie in the sac wall, empty the sac of its fluid and reduce it *en masse* after removing all skin from over it. If the case be discovered to be one of meningocele, remove the whole sac after suturing its base.

Step 4.—Close the wound by a series of deep and superficial sutures.

Babcock's Operation.—("Monthly Cyclo. and Med. Bull.," May, 1911.) Fasten a blanket firmly between the upright rod legholders on an ordinary operating table. Hang the child over this by its groins (Fig. 883) fastening the legs by bandages to keep it from slipping. In front of the blanket place a hot-water bottle opposite the child's abdomen to prevent chilling. Have an assistant at the other side of the blanket to manage the head, watch symptoms and if necessary administer an anesthetic. Sterilize abraded or ulcerated areas with pure carbolic acid followed by alcohol. Paint the whole area with tincture of iodine.

Step 1.—Through a fine needle inject into the cephalic part of the sac 3 centigrams novocaine or 2 centigrams stovaine, dissolved in 1/2 c.c. sterile 10 per cent. alcohol. Inject slowly, withdrawing the piston several times during the injection to insure thorough mixing of the analgesic with cerebrospinal fluid. The low specific gravity of the mixture prevents it affecting the higher centres of the cord while the child is inverted, and of course most of it escapes during the operation so subsequent danger is averted.

Step 2.—If the sac is not too thin dissect away all abraded and ulcerated areas and disinfect again. By transillumination note the position of nerve filaments and of portions of spinal cord so as to avoid them. Free the skin from the sac and retract the former.

Step 3.—Puncture the sac. Resect redundant sac if there is room between adherent nerve elements, otherwise let it collapse into the spinal cavity. With a continuous fine (00 to 000) chromicized catgut suture fix the sac so that it cannot unfold.

Step 4.—Incise the edge of the dura where it blends with the inner surface of the laminæ and strip it from the bony canal for the entire length of the defect. Suture the mobilized dura over the cord thus restoring the dural canal.

Step 5.—Freely expose the margins of the bony canal and divide the laminæ

with bone forceps (Fig. 884). This forms a ribbon of bone and fibrous tissue on each side of the defect. Suture the two ribbons together and thus restore the bony canal (Fig. 885).

Step 6.—From the erector spinæ muscles on each side of the defect form two flaps of muscle and overlying aponeurosis, attached above and below. Suture these two flaps in the middle line. Close the skin wound with mattress sutures so that there is eversion and the thin skin is so approximated that leakage and necrosis is not likely to occur.

Some surgeons have recommended that the osseous defect be closed by means of a flap of bone obtained from the crest of the ilium and provided with a pedicle. This procedure must rarely be indicated.*

FIG. 883.—(*Babcock.*)

Operations to Immobilize the Spine in Pott's Disease.—Apart from hygienic measures and the treatment of abscesses, immobilization has been and still is the desideratum in the treatment of tuberculosis of the bodies of the vertebræ. As a substitute for mechanical supports and braces the following osteoplastic operations have been devised and carried out.

Hibbs' Operation.—Object: To produce fusion of the bones of the spine from a point two vertebræ above to a point two vertebræ below the diseased bones.

1. Make a vertical median incision sufficient to give ample access to the diseased vertebræ and to two healthy vertebræ above and also below the disease.

* For a thorough description of spina bifida and its operative treatment the reader is referred to Hildebrand' article in the "Archiv f. klin. Chirurgie," Bd. xlvi, He ft 1.

2. With *sharp* and blunt dissection separate the periosteum from the spinous processes and the laminæ on each side, carefully separating it and the interspinous and interlaminar ligaments from the upper and lower edges of the spinous processes and the laminæ. Continue the dissection outwards until the posterior surface of the transverse processes are bared. The periosteum and interspinous ligaments must be reflected to each side as a single flap continuous from the upper to the lower end of the wound. In the centre of the wound lie the spines and laminæ entirely bare of periosteum, their upper and lower edges being also bare. No tags of fibrous tissue must be present. During the whole of the dissection *no muscle should be seen;* if the muscular planes are penetrated the dissection has been faulty and bleeding will give annoyance.

3. With a chisel or gouge cut a thin slice of bone from the surface of the lower half of each lamina, the pedicle of this bone flap being on the base of the corresponding transverse process. Turn the bone flap downwards in such a manner that it bridges the interlaminar space vertically and its raw surface lies flatly in contact with the lamina of the next vertebra. Hibbs thinks the greatest value of this step is the production of a bony buttress preventing the interposition of fibrous tissue which might interfere with bone fusion.

FIG. 884.—(*Babcock.*)

1. Skin; 2, muscle and aponeurosis; 3, bone flap; 4, sutured dura.

4. With bone-cutting forceps divide the base of each spinous process throughout the upper three-fourths of its vertical diameter (the lowest vertebra is divided throughout its *lower* three-fourths). Fracture and turn downwards each spinous process (the last one is turned upwards) so that there results a vertical row of fragments of bone overlapping each other.

5. Suture the periosteal and fascial flaps over the bones. Close the skin wound. If the operation has been properly performed there will be very little bleeding and no drain is required. Every detail of the work can be done with instruments, so that it is unnecessary and therefore objectionable, to put a finger in the wound. Apply dressings. Hibbs believes that the treatment of the spinous processes is the least important step in the operation.

6. Immobilize the spine in a jacket for one year.

Remarks.—While suitable for old neglected cases, the operation is particularly valuable in early disease. If psoas abscess is present, evacuate the tuberculous pus and close the puncture a day or two before attacking the spine.

Albee's Operation.—("Journ. A. M. A.," Sept. 9, 1911).

Step 1.—Make a median dorsal incision over the tips of the spinous processes from the last healthy vertebra above to the first below the affected bones.

Step 2.—Split longitudinally each process for about 1¼ inches into two portions with one-third of the process on the left and two-thirds on the right. Separate the soft structures between the processes parallel with the muscles. Produce a green-stick fracture at the base of the one-third portion of each of the processes. Temporarily pack the long gutter-shaped wound.

Step 3.—Make an incision over the side of the tibia and reflect the skin so as to expose the crest of the bone. (It is best not to have the skin incision directly over the segment of bone to be removed.) With a chisel remove a prism-shaped

FIG. 885.—(*Babcock.*)

1. Skin everted and sutured; 2, musculo-aponeurosis flap united; 3, bone flaps united; 4; dura united; 5, reconstructed cavity of spinal arachnoid.

piece with the periosteum intact on two of its surfaces from the antero-internal aspect of the tibia. This piece of bone must be long enough to reach from the uppermost to the lowest of the split vertebræ; it should be about 1 inch wide and ½ inch thick.

Step 4.—Place the fragment of bone in the gutter prepared on the back, between the fragments of the split spinous processes. Suture the dense fascia over the tips of the spinous processes. Close the skin wound. Dress. Immobilize.

Step 5.—Close and dress the wound in the leg.

PART VI

CHAPTER LX

NERVES

NERVE SUTURE; NEURORRHAPHY

Nerve Suture.—A few words on the repair of nerves after division may be forgiven in view of the importance of understanding some of the possibilities of operative interference.

The older doctrine of repair was that after division the whole of the distal segment degenerated, and that if restoration of function took place, it was due to the proximal segment sending new nerve filaments through the whole of the degenerated distal segment, the distal segment itself being merely a guide or path through which the new nerve fibres grew. If there was a wide space between the cut ends of the nerve, or if some substance was interposed between the ends, then the peripheral segment would so completely change in character as to become useless as a guide. If this old doctrine is true, secondary or late nerve suture is useless.

Another and more hopeful doctrine of repair is that while degeneration of the distal segment is taking place the cells of the neurilemma proliferate and form chains or bands of overlapping spindle cells and that a new nerve fibre develops from these. According to Ballance and Stewart, the new axis-cylinder remains immature unless it unites with an axis-cylinder of the central stump. If this doctrine of peripheral regeneration is true, secondary nerve suture may be expected to give more or less satisfactory results as long as the new-formed immature axis-cylinders persist and as long as the muscles supplied remain capable of function.

It is believed that nerves provided with a neurilemma are capable of repair under favorable circumstances, but that those without a neurilemma are incapable of repair under any circumstances. For some unknown reason sensory nerves repair much more readily and quickly than do motor ones (*e.g.*, recurrence of facial neuralgia after nerve section or even excision).

Restoration of function after the repair of a nerve takes place in the following order: (*a*) restoration of the trophic energy of the tissues; (*b*) sensation; (*c*) motion; (*d*) material increase of the substance of muscles which for months have been inactive, except where the muscular tissue has degenerated beyond repair.

The time which elapses between nerve suture and functional repair varies

enormously. Sometimes prickling sensations may be experienced a few days after operation, and motion has been restored in from 8 weeks to 3½ years.

Primary Neurorrhaphy.—When a nerve of any importance is divided, it ought to be at once sutured. The favorite suture materials are silk and fine chromicized catgut. The needles used should be as fine as possible and either round or flat to avoid needless division of axis-cylinders.

Direct Suture.—The stitch includes in its bite the sheath as well as the body of the nerve. Such a stitch must be supported by sutures involving the sheath alone.

Indirect Suture.—Fibrous tissue around the divided nerve is united by sutures and thus holds the ends of the nerve in apposition.

It is well to combine the indirect and direct methods. If there is loss of nerve substance and a gap exists between the ends, they may be brought together by stretching their trunks, if foreign material may be implanted to bridge the gap.

Secondary Neurorrhaphy.—A nerve has been divided by injury; recovery from the injury is complete, but the nerve has never been united; to effect union, the operation of secondary neurorrhaphy is necessary.

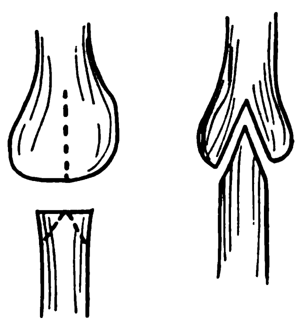


FIG. 886.

Step 1.—With, or preferably without, a tourniquet make an incision along the course of the nerve at the point of injury. By dissection expose both proximal and distal portions. The former will be found bulbous, the latter probably filamentous. If the ends cannot be found readily, enlarge the incision, expose the trunk above and below, and follow it to the site of injury. The distal segment may be so altered as to be difficult of recognition; to identify it Murphy recommends the use of the nerve exciter. This is composed of a metallic cylinder which can be attached at one end to a faradic battery, while the other end is provided with two platinum needles or wires, 3 centimeters in length, and ½ centimeter apart. These tips can be readily sterilized. Excise intervening scar tissue.

Step 2.—Vivify the ends of the nerve by paring with a sharp knife. Never sacrifice more than ¼ inch from either end in this procedure. It is unnecessary to remove all the bulb on the proximal stump (Bowlby, Jacobson). Unite the ends by suture, if necessary, stretching the proximal portion of the trunk to obtain apposition.

An extraordinary case of secondary nerve suture of the facial nerve is reported by Emmet Rixford. Eight weeks after any injury the facial nerve was identified as it left the stylomastoid foramen and was found to be divided 1 cm. below this point. The distal segment was found with great difficulty by first exposing the two principal branches in the parotid and tracing them back. The gap between the segments was about 1 cm. The proximal segment

after vivification was so short that stitches could not be introduced. Rixford cut away enough of the mastoid process and the external wall of the aqueduct of Fallopius so that the nerve could be mobilized and the two segments united by sutures. The result was entirely good. In repose the two sides of the face looked alike and the patient could close the eye on the affected side independ-

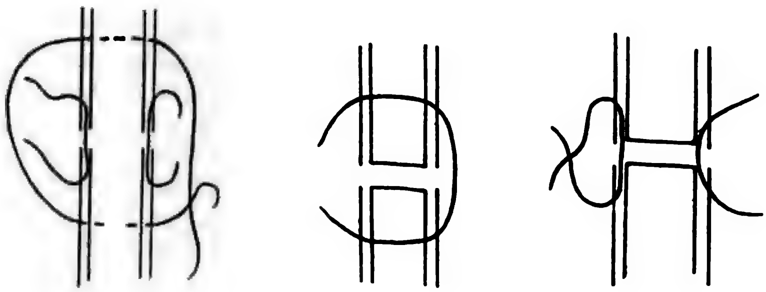


Fig. 887.

ently of the other with an expressive wink. ("Trans. Am. Surg. Assoc.," xxii.)

The methods of applying sutures (silk, hemp, catgut, preferably inserted by means of intestinal needles) are sufficiently shown in Figs. 886, 887.

When direct apposition of the divided ends of the nerve is impossible various means of bridging the gap have been devised; some of the best of these are shown in Figs. 888, 889, 890.

When a divided nerve has been united by cicatricial, but not by nerve tissue, repair may be obtained by Bruns' method (Fig. 891).

Implantation of nerve from the human body or of the sciatic nerve or spinal cord of other animals (*e.g.*, rabbits) has been employed. Glück recommends placing these grafts inside decalcified bone tubes and tucking the vivified stumps of the nerve to be united into the open ends of the tube, there fixing them with sutures.

Formalinized portions of arteries may be used in place of the bone tubes, (Foramitti).

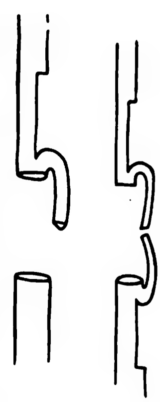


Fig. 888.

Powers ("Trans. Am. Surg. Assoc.," xxii) comes to the following conclusions: "Although correction of the evils resulting from a gap in the continuity of a nerve is a matter of great importance in a given case, it hardly seems possible at this time to say definitely what form of bridging should be employed. More cases, and especially cases recorded later and better, are needed. Neoplasty and implantation (anastomosis) are always available resources, and for the present it would seem that they should be preferred. Resection of bone may be advisable in selected cases. Transplantation of foreign grafts should be abandoned. It is hardly necessary to say that prognosis in an individual case should always be guarded and that repeated operations may be necessary."

Verga ("La Clinica Chir.," xviii, No. 1, Ref. "Journ. de Chir.," April, 1910) as a result of a series of experiments came to the following conclusions:

1. Sutures of the ends of the nerve brought into apposition by stretching (Schüller's method) permit the repair of losses of substance of about 2 to 3 cm.

2. "Distance sutures" give equally good results whether catgut or silk is used.

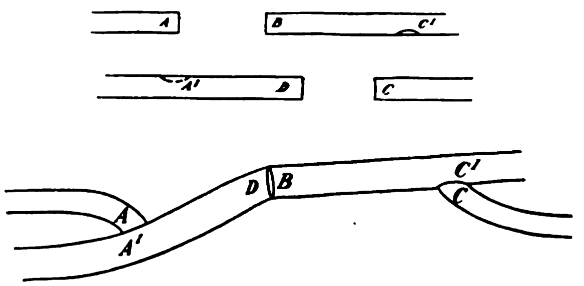


FIG. 889.—Two parallel nerves divided at different levels, with loss of substance from each. Unite A to vivified point A'. Unite D to B. Unite C to vivified point C'.

3. Tubular suture. Fresh arteries give good results; rubber tubes mediocre, while Payr's metallic tubes (magnesium) seem better as protectors after neurorrhaphy than as tubular sutures.

4. Homo- or heteroplastic transplants give apparent union, but the implant surely degenerates and only acts as a guide into which new nerve fibres penetrate from the central segment.

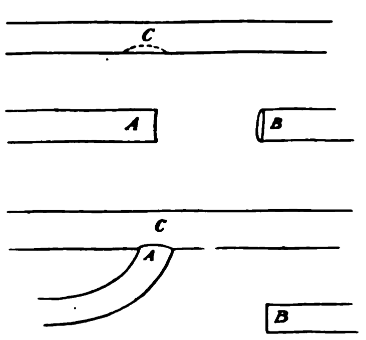


FIG. 890.—Nerves divided—loss of substance. Unite end A to vivified point C on neighboring and parallel nerve. Ignore segment B.

5. Autoplasty by flaps (autoplastic elongation) ought to be abandoned. It aggravates instead of ameliorating the lesion.

6. Termino-lateral anastomosis provides an anatomical reunion and histologically it can be demonstrated that fibres pass directly from the nerve implanted into the nerve to be regenerated. Neurotization of the paralyzed trunk may be obtained however the operation is performed and even if the

stump is not vivified. The healthy nerve suffers more or less from the operation, but its lesions recover by the same processes as the paralyzed nerve.

7. After neurectomy the actual cautery applied to the nerve stump does not prevent regeneration.

Treutlein ("Münch. med. Woch.," June 19, 1906) reports that remarkably good results were obtained by the Japanese during the Russo-Japanese war by covering the line of suture or of bridging of nerves by formalinized arteries which had been preserved in alcohol.

In a case of fracture of the humerus in which 4 cm. (one and a half inches) of the musculo-spiral nerve had been destroyed Ramsauer excised a 10 cm. (four inch) segment of the basilic vein, threaded four silk sutures through the excised vein, used these threads thus covered or insulated to bridge the gap in the nerve. Fairly good function was reestablished in six months.

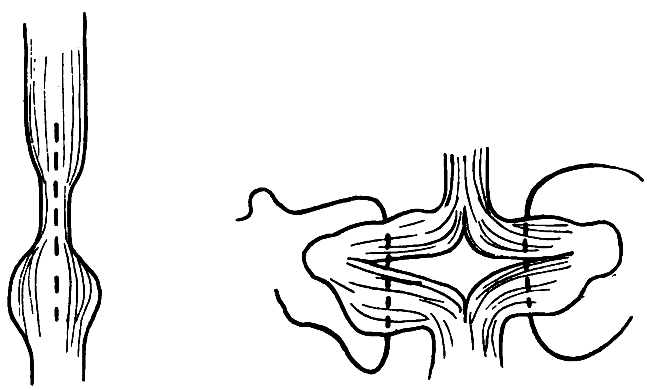


FIG. 891.—Brun's neuroplasty.

Lotheisen uses gelatin tubes hardened in formalin and preserved in alcohol. Murphy, when possible, protects the line of union with fascia, muscle or fat. When this is impossible, *e.g.*, at the ankle or wrist, he envelops the line of union with Cargile membrane or with a sheet of paste made from equal parts of oil of sesame and paraffin with a melting point of 107° F.

Andrew Fullerton (Brit. Med. J., Aug. 28 1915) in secondary neurorrhaphy covers the lesion with a segment of vein as follows: Find and free the nerve from surrounding scar tissue. One segment of the nerve must be isolated far enough so that a segment of vein may be pulled completely over it. Trim the end of the nerve projecting from the vein and unite it to its fellow. Slide the vein over the site of union and fix it with a few stitches.

The favorite method of bridging the gap is by means of several strands of chromicized catgut (distance sutures). In order to unite severed nerves, several surgeons have successfully excised segments of the humerus or of the forearm bones, thus shortening the limb and attaining their aim.

After neurorrhaphy or nerve transplantation complete rest of the parts, *without tension on the line of suture*, must be maintained until union is complete.

The subsequent teatment consists in massage, electrical stimulation, and proper gymnastics. Excellent function is sometimes obtained long after all hope of such has been abandoned. Sensation may be expected to return before motion, generally after the lapse of two to four weeks. Motion is rarely obtained until months after operation. In 76 cases of neurorrhaphy (Tillmanns) 67 per cent. were successful. Of these 76 cases, 33 were secondary operations with 24 decided successes.

As in the case of tendon, so with nerves, various methods of transplantation may be used. Dumstrey ("Zentralblatt f. Chir.," 1902, p. 376) describes a case where the ulnar nerve was extensively destroyed more than two years previously by a fracture of the elbow. He implanted the peripheral portion of the nerve into a button-hole in the median nerve, and inserted "distance sutures" of catgut between the proximal portion of the ulnar and the same point in the median. Within three months there were a notable return of sensation, beginning of motion, and a loss of previously existing contracture.

A case of extensive destruction of the radial nerve is reported by C. Sick and A. Saenger ("Archiv f. klin. Chir.," liv, 271), who operated as follows: (1) Exposure peripheral portion radial nerve in forearm. (2) Exposure median nerve in forearm through the same incision. (3) Splitting of a flap, with base upwards from the median nerve. (4) Conduction of this flap under the muscles and suture of it to the exposed portion of the radial nerve. After several months there was no improvement, but when 1½ years had elapsed the paralysis had almost entirely disappeared.

Suture of Recurrent Laryngeal Nerve.—Shelton Horsley ("Annals of Surg.," li, 524) reports a case in which the left recurrent laryngeal nerve was divided by a bullet at a point just before the nerve entered the larynx. The voice was hoarse and weak. Respiration was impeded. The left vocal cord was paralyzed and the larynx above the glottis was congested. Horsley operated as follows: Make an incision along the anterior border of the left sterno-mastoid. The middle of this cut is opposite the inferior limit of the larynx. Retract the sterno-mastoid and with it the carotid and internal jugular outwards. Expose the left lobe of the thyroid and retract it to the right along with the trachea and larynx. Look for the nerve in the groove between the trachea and œsophagus. In Horsley's case the wounded part of the nerve was surrounded by a mass of scar tissue. About 8 mm. of involved nerve was excised and the divided ends united by a fine catgut suture. Six days after operation there was no improvement in the symptoms. Three months later the movements of the glottis were almost normal though the left vocal cord seemed a little weak. The voice was no longer hoarse but had not regained its full volume. Shepherd has successfully sutured the recurrent laryngeal nerve after it had been accidentally divided during a strumectomy.

Kenneth MacKenzie's work on resection of the sciatic nerve is of very great importance even although it consists of the report of a single case ("Annals of Surg.," July 19, 1909).

Because of agonizing pain, etc., resulting from a tumor of the sciatic nerve,

ten and three-quarters (10¾) inches of the nerve was removed (x–y, Fig. 892). The wound was closed and healing took place. Twenty-one days after the first operation an incision was made along the line of the original cut in the thigh but extending down to a point immediately behind the internal malleolus.

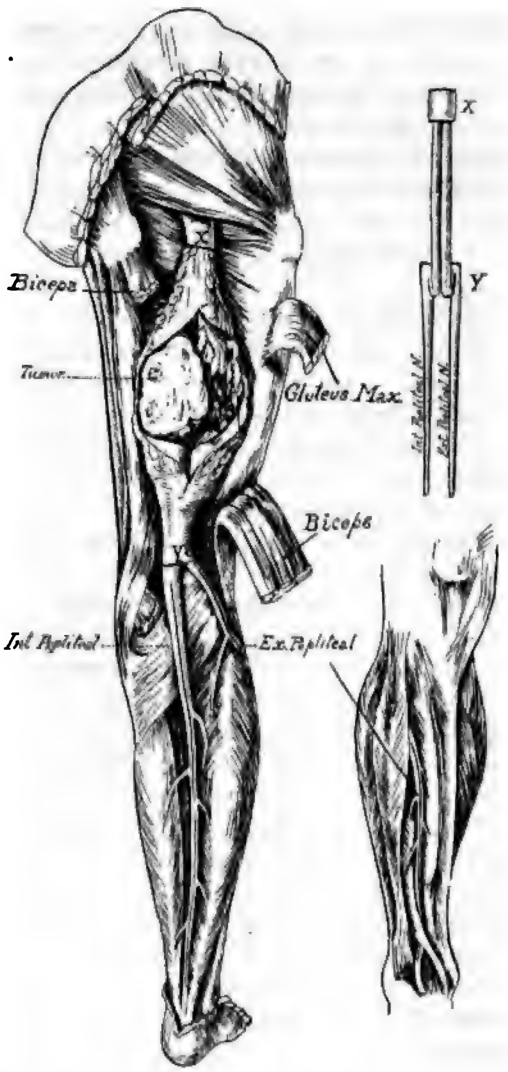


FIG. 892.—Resection sciatic nerve. (*Mackenzie, Annals of Surg.*)

Through this long incision the stump of the sciatic nerve was exposed, the ends of the popliteal nerves were found (and the external anastomosed laterally to the internal), the internal popliteal nerve was exposed down to the ankle and from it a flap 16¾ inches long and about 1½ line in diameter and reflected upwards, care being taken to avoid the division of any collateral branches.

The end of the long flap was implanted into a split made in the stump of the sciatic nerve. The flap "was carefully placed over the underlying muscles and imbedded in them throughout its length by a slender iodized suture." Healing was *per primam* and there was much improvement.

Sixty-seven days after the first operation exposure of the nerve tract showed a definite path of nerve tissue in the sciatic gap. The external popliteal nerve was now exposed and a flap split from it was placed alongside the original graft, but tucked in a separate muscular bed. Healing *per primam*. (Fig. 892 explains the steps of the operation.)

Immediately after the primary operation not only was all sensory and motor transmission eliminated throughout the sciatic area, but in addition all means of conveyance of stimuli by afferent nerves of whatsoever kind. There were marked trophic disturbances. The result of the reparative operation was:

"1. Trophic recovery is practically complete. There is now no tendency to the formation of blebs and ulcers and the skin has recovered its natural texture and color.

"2. There has been extensive development of protopathic sensibility, much more than could possibly be explained by overlapping from the district of the anterior crural nerve.

"3. There has been much recovery of epicritic sensibility, as shown by comparison of the areas of sensory distribution in both legs by diagram.

"4. There is also universal recovery of deep sensation, which is said to be lost when all motor and all sensory nerves to a given part are divided.

"5. Recovery has taken place of motion and power in large groups of muscles, which immediately after the excision of the nerve were reduced to a paralytic state, displaying the usual signs of paralysis and the reaction of degeneration.

"6. The sign afforded by the foot. In the earlier stages of locomotion the foot was helpless and dragged; at the present time it shows muscular control and easy locomotion.

"7. The relatively small area of thermic anesthesia, which is practically coterminous with the area of absolute analgesia.

"8. The direct sensibility of the new nerve-tract to deep pressure and the transmission of painful sensibility thereby to the foot.

"9. The possession of muscular sense unimpaired.

"10. Independent and unaided locomotion."

Direct Implantation of a Nerve into Muscle.—Attempts to restore function to a paralyzed muscle have usually been made by anastomosing a healthy motor nerve to the nerve trunk which supplied the muscle. Heineke (Zent. für Chir., 1914, No. 11) conceived the idea that by implanting the sound nerve into the muscle, the axis cylinders might either distribute themselves to the individual muscle fibres by growing into the preexisting nerve paths or might reach the muscle fibres directly and form new nerve endings.

Heineke and his assistants produced paralysis of certain muscles in rabbits by exposing the two branches of the sciatic nerve (tibial and peroneal) and ex-

2 cm. of the tibial nerve. The peroneal nerve was then exposed down-
id divided below the head of the fibula. The central end of the
nerve was now pulled through a tunnel bored in the gastrocnemius
there. After 14 days the gastrocnemius responded slightly to faradic
mic stimulation of the peroneal nerve in the thigh. After four weeks
ion was powerful while "after eight weeks the power and extent of the
ons could not be distinguished from the normal and were not confined
uscle in which the nerve was implanted but the neighboring muscles
xor group took part in the contractions. The muscles which were at
phied and yellow regained their normal color and consistence." A
ervated for 21 days can recover after direct implantation of a healthy

NERVE ANASTOMOSIS

[illegible] Anastomosis for Facial Paralysis.—The first operation of this [illegible] performed by Ballance and Purves in [illegible]. [illegible] operated in [illegible], [illegible] Robert Kennedy in a case of severe facial spasm [illegible] the facial [illegible] the proximal extremity of [illegible] the [illegible] spinal accessory nerve. The re[illegible] perfect.

[illegible] by Cushing "Annals of Surgery," May [illegible] nerve was destroyed [illegible]

[illegible]

Stewart, later by Frazier. The glossopharyngeal nerve has also been similarly used. The various operations for facial palsy may be systematized as follows:

Anatomy.—The facial nerve emerges through the stylo-mastoid foramen where it is deeply seated; from here it runs "downwards, outwards and a

Fig. 893.—Nerve anastomosis. (*Cushing, Annals of Surg.*)

little forwards to turn or wind round the styloid process, after this its course is almost horizontally forwards until it crosses the posterior auricular artery and immediately plunges into the parotid gland. The horizontal portion

of the nerve is situated at the level of the tip of the lobule of the ear, *i.e.*, about ¾ inch below the lower border of the zygomatic arch."

The Spinal Accessory Nerve.—The external, spinal or surgical portion of this nerve emerges from the skull through the jugular foramen; from here it passes downwards, outwards and a little backwards in front of (rarely behind) the internal jugular vein between that vein and the occipital artery which crosses it perpendicularly. The nerve now lies exactly between the *transverse process of the atlas* and the posterior border of the digastric. Below this point the nerve passes behind the posterior border of the parotid to enter the deep surface of the sterno-mastoid 2 inches below the apex of the mastoid process.

The Hypoglossal Nerve.—The hypoglossal nerve leaves the skull through the anterior condylar foramen and lies on the inner side of the deep cervical vessels. As it descends, the nerve comes forward between the internal carotid artery and jugular veins to the lower border of the digastric muscle where it curves forwards round the origin of the occipital artery, the sterno-mastoid branch of which turns downwards over the nerve. From this point the nerve runs forwards above the hyoid bone, passes under the tendon of the digastric, the lower end of the stylo-hyoid and the mylo-hyoid muscles, and crosses the external carotid and lingual arteries.

Spino-facial Anastomosis.—Step 1.—Incision along the anterior border of the sterno-mastoid, beginning above in the groove between the external ear and the mastoid at the level of the tragus and ending at a point about 5 inches lower.

Step 2.—Retract the ear forwards. Divide the fibrous tissues covering the mastoid so as to gain access to its anterior border. Expose the anterior border of the sterno-mastoid.

Step 3.—With blunt dissection penetrate between the parotid, the anterior border of the mastoid. Move the dissecting instrument horizontally and *not* vertically, to avoid injuring the nerve. The nerve should be found at a depth of a little less than ½ inch from the surface of the mastoid at the junction of its lower and middle thirds (Marion). Isolate the nerve and divide it as far back as possible.

Step 3.—Open the sheath of the sterno-mastoid longitudinally. Demonstrate the transverse process of the atlas about ½ inch below the mastoid, and expose it clearly to sight by bluntly dividing the fibrous tissues covering it. Demonstrate the posterior belly of the digastric in front of the atlas. The spinal accessory nerve lies between the transverse process of the atlas behind and the digastric in front. Isolate the nerve.

Step 4.—Divide the nerve at its entrance into the sterno-mastoid, and make an end-to-end anastomosis between its proximal segment and the distal segment of the facial. Instead of completely dividing the spinal accessory nerve, a hole may be cut in its side and into this the facial nerve implanted (end-to-side anastomosis). The end-to-end anastomosis seems preferable.

Step 5.—Bury the line of nerve suture in the belly of the digastric muscle after incising the muscle for this purpose.

Step 6.—Close the wound with buried and superficial sutures.

Hypoglosso-facial Anastomosis.—*Step* 1.—From a point on the level of the tragus, in the groove between the external ear and the mastoid, make an incision downwards along the anterior border of the sterno-mastoid to a point a trifle below the angle of the jaw; from this low point cut forwards horizontally on the level of the hyoid bone, for about 1 inch.

Step 2.—Expose and divide the facial nerve as in the spino-facial anastomosis.

Step 3.—In the lower part of the wound open the sheath of the sterno-mastoid anteriorly, retract the muscle backwards, divide the deep layer of the sheath of the mastoid at the level of the greater horn of the hyoid. The hypo-

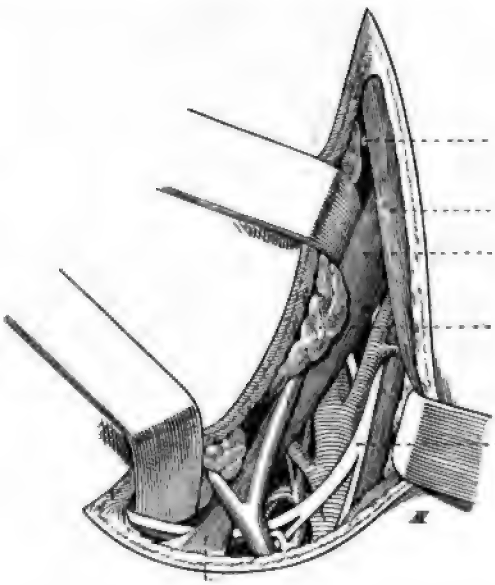


FIG. 894.—Exposure of hypoglossal nerve. (*Marion.*)

glossal nerve is to be sought either posteriorly where it crosses the external carotid (Fig. 894) or anteriorly between the greater horn of the hyoid and the posterior belly of the digastric.

Step 4.—Free the nerve very gently from its surroundings. Divide the nerve so far forwards that enough isolated nerve trunk is left to be turned upwards and forwards and united without tension to the distal segment of the divided facial nerve. Complete the anastomosis.

Steps 5 *and* 6.—As in spino-facial anastomosis.

Indications for Operation for Facial Palsy.—1. Where it is known that the facial nerve is completely divided, immediately unite its divided ends if possible; if this is impossible perform spino-facial or hypoglosso-facial anastomosis as soon as possible.

2. When there is reasonable doubt as to the permanency and completeness

of the lesion, delay is justifiable. If there is no sign of recovery in six months, operate (Frazier).

3. In old cases test the facial muscles, if they are completely atrophied and no longer respond to the faradic current, probably operation will do no good. If the muscles respond to faradic stimulation operation is proper.

4. Facial palsy from "cold." This is probably an infective neuritis (Spiller). The prognosis is usually good without operation. If, after four to six months, the facial muscles are still almost completely paralyzed and reaction of degeneration is pronounced, Spiller would recommend anastomosis. The same rules apply to facial paralysis from middle ear disease.

Choice of Operation.—1. In palsy from division of the facial nerve immediate reunion is always desirable, but not often possible.

2. Spino-facial anastomosis is somewhat more easily performed than is the hypoglosso-facial operation, and the muscles paralyzed by the nerve section are less important. The spinal-accessory nerve, however, is dominated by the centres for associated movements of the shoulder, hence after operation there are liable to be movements of the facial muscles every time the patient raises his shoulder. Mr. Ballance has given up spino-facial anastomosis on account of the difficulty of securing dissociation.

3. Hypoglosso-facial anastomosis is not much more difficult than spino-facial, the muscles supplied are not of prime importance. The hypoglossal cortical centre is functionally more allied to the facial centre than is that of the spinal accessory.

Spiller writes: "In employing hypoglossal as the nerve for anastomosis with the facial it is possible that emotional movements may be restored, and such seems to have been the result in a case observed by Köster and Bernhardt, in which the corner of the mouth on the affected side was moved during laughter."

Treatment of Facial Paralysis by Muscle Transplantation.—A. Jianu ("Deutsche Zeitsch. für Chir.," cii, p. 577. Ref. "Journal de Chir.," Feb., 1910) has operated by taking a flap from the sterno-mastoid muscle (pedicle above) and suturing it to the angle of the mouth. The result was satisfactory. Jonnesco, following Jianu's principle, exposed the masseter by a curved incision following the edge of the inferior maxilla (both the ascending and horizontal rami); split the masseter in the direction of its fibres; separated the anterior portion of the muscle from its insertion into the jaw, and so formed a muscular flap attached to the zygoma. This flap he sutured to the angle of the mouth. The result was correction of the deviation of the mouth; prevention of the escape of saliva; ability voluntarily to move the angle of the mouth.

The operation does not pretend to remedy the paralysis of the orbicularis muscle and must be of very limited value. Cuneo remarks that Jianu's operation should be reserved, in cases of total facial paralysis to those in which nerve anastomosis has failed, and that when performed it should be supplemented by some operation on the eyelids, such as angular tarsorrhaphy.

Lexer (Eden, Beitr. z. klin. Chir., lxxiii, 123) has used a slip of masseter to support the mouth. His incision penetrates the skin and subcutaneous

tissues in the naso-labial fold. From this cut he burrows back and down until the parotid is reached. The parotid is now retracted bluntly upwards and forwards to expose the insertion of the masseter from the anterior margin of which a flap 1 cm. wide, with pedicle above, is detached and sutured to the tissues near the angle of the mouth. If there is paralysis of the eyelids a similar flap may be obtained from the temporal muscle and sutured to the external angle of the eye. The primary incision is vertical and made inside the temporal hair line; a small secondary incision close to the eye is necessary to permit suturing.

II. DUCHENNE-ERB PARALYSIS—OBSTETRICAL PALSY

Paralyses of certain groups of muscles in the upper extremity may be recognized soon after birth. The origin of these paralyses is disputed. Until recently they were ascribed exclusively to tearing, stretching or compression of the brachial plexus during birth (Duchenne) or to trauma received later in life. The part of the plexus affected is believed to be at that point where the anterior primary divisions of the fifth and sixth cervical nerve roots unite. The motor fibres in these two nerve roots supply the deltoid; supraspinatus and infraspinatus; biceps; brachialis anticus; supinator longus and brevis, and the teres minor. Thus in a typical case of Duchenne-Erb paralysis the arm cannot be abducted at the shoulder, flexion of the elbow is impossible, the forearm is in a position of pronation, the whole arm is rotated outwards to such an extent that the palm of the hand may be directed outwards.

Wilfred Harris and V. W. Low ("Brit. Med. Journ.," Oct. 24, 1903) believe that Markoe's case ("Annals of Surg.," 1885, ii, 185) of division of the fifth cervical root proves that the deltoid, spinati, biceps, and brachialis anticus derive their whole motor supply from this source, while the supinator longus is, at least in part, indebted to it for its motor impulses.

Turner Thomas ("Annals of Surg.," Feb., 1914) disputes these views vigorously. "The fact that in most cases there is practically no disturbance of sensation in the affected limb, although the roots of the brachial plexus are all mixed nerves, has not been satisfactorily explained." He believes that the great majority of cases of obstetrical paralysis of the upper limb are due to pressure on the front of the shoulder during birth, causing a bending down of the acromion process and specially a posterior subluxation of the head of the humerus. The bending of the acromion interferes with reduction. The fact that when this subluxation cannot be recognized after birth, spontaneous reduction being assumed to have occurred, complete recovery ensues under any or no treatment, also the fact that late correction of the persistent subluxation leads to improvement, support his views.

The presence of extensive adhesions about the plexus, as demonstrated at operation, renders doubtful the presence of ruptured nerve roots occasionally described, because of the great difficulty in dissecting accurately these delicate and interweaving structures under the unfavorable local conditions. Turner

Thomas believes the adhesions are due to a spread upwards, no great distance, of the reparative inflammation at the injured shoulder joint. Lange, at operation, in one case found the cause of the paralysis to be the imbedding of the branches of the plexus in thick connective tissue in the axilla, and found also a diminution and deformation of the head of the humerus.

Immediately after birth reduction of the subluxation will probably be easy; after some months it is difficult because of anatomic changes. Thomas states, "the first indication at any stage is to reduce, the next to obtain the best possible motion at the shoulder joint." If the surgeon believes injury to the brachial plexus is primarily at fault (the author is strongly inclined to consider that Turner Thomas is correct in denying this), then when a case presenting the symptoms enumerated shows no improvement after two or more months of treatment by electricity, massage, etc., but, on the contrary, the electrical reactions of degeneration begin to appear, then operative treatment becomes

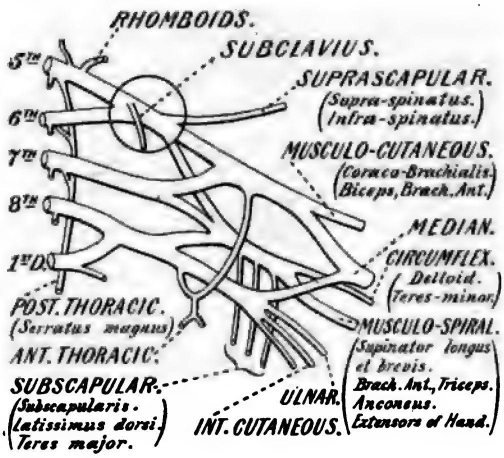


FIG. 895.—Duchenne-Erb paralysis.

proper. There are two methods by which improvement may be attained—one by nerve anastomosis, the other by muscle transplantation or transference.

(A) Direct Method.—*Robert Kennedy's Operation.*—("Brit. Med. Jour.," Feb. 7, 1903). Place the patient on his back, with a pan under the shoulders to permit of the head being well thrown back. Incline the head and face to the opposite side.

Step 1.—From the junction of the middle and lower thirds of the outer margin of the sterno-mastoid make an incision outwards and downwards to the junction of the outer and middle thirds of the clavicle. Divide the deep fascia between the sterno-mastoid and trapezius. Expose the omo-hyoid below the lower edge of the wound. Above the omo-hyoid expose the scalenus anticus muscle and demonstrate the nerve-trunks emerging from under it. Trace the two upper nerve-trunks outwards to their junction.

Step 2.—Having found the junction of the fifth and sixth nerves, recog-

nize the various branches and free them from adhesions (Fig. 895). Free the main trunks from the adhesions which seem to be always present.

The accompanying illustrations (Figs. 896, 897) taken from A. S. Taylor's article on "Brachial Birth Palsy" ("Journ. A. M. A.," Jan. 12, 1907) illustrate well the anatomy of the brachial plexus.

Step 3.—Note the condition of the isolated nerve. Kennedy has always found it to be in a hopelessly cicatricial condition. If the whole nerve seems to be composed of scar tissue, divide the fifth and sixth above the diseased area. The cut surface ought to show a healthy appearance; if not, slice off more of the nerve until healthy tissue is reached. Pull the diseased area in-

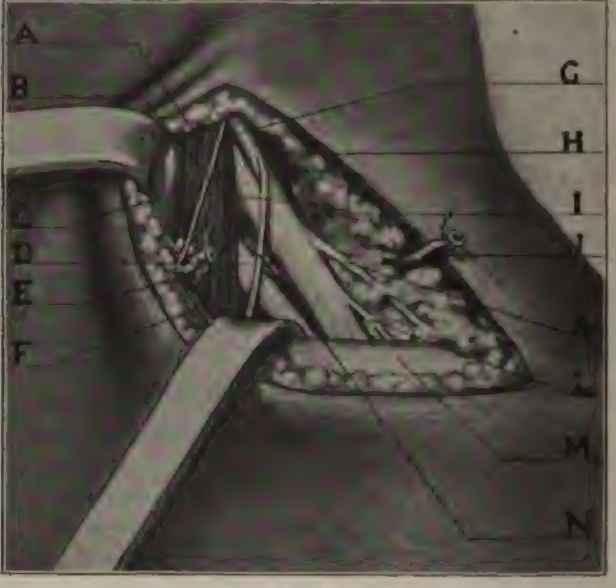


FIG. 896.—(*Taylor.*)

A. Scalenus anticus. B. Phrenic n. C. Int. jugular. D. Transversalis colli a. E. Seventh root. F. Omo-hyoid. G. Fifth root. H. Scalenus medius. I. Sixth root. K. Suprascapular n. L. Ext. ant. thoracic n. M. Clavicle. N. Nerve to subclavius.

wards and put on the stretch the three peripheral divisions of the nerve, viz., the supra-scapular nerve, the branch to the outer and that to the posterior cord of the plexus. Divide these three branches at points beyond the disease, the section being made through healthy nerve.

Step 4.—Suture the three peripheral stumps to the two proximal stumps of nerve by means of fine chromicized catgut threads. Before approximating the divided nerve ends and tying the sutures, push the shoulder upwards and incline the head to the side being operated upon. This relieves tension, and permits of approximation. Cover the line of nerve suture with muscle, fascia or some material like Cargile's membrane.

Step 5.—Close the external wound. Apply dressings. With plaster-of-Paris or a suitable apparatus, keep the shoulder elevated and the head inclined

to the side on which operation has been performed, and, above all, prevent motion of the head on the shoulders. When the lesion is more extensive, especially when it lies beneath the clavicle, continue the skin incision downwards between the pectoralis major and deltoid. Separate these muscles. Divide the clavicle in the same line, also the sub-clavius and omo-hyoid muscles and supra-scapular vessels. Pull the outer fragment of the clavicle and the shoulder outwards exposing the entire plexus to the upper margin of the pectoralis minor, which may also be divided if necessary. When the nerve suture is completed reunite the divided muscles and bone.

FIG. 897.—(*Taylor.*)

A. Phrenic n. B. Scalenus ant. C. Int. jugular. D,O. Transversalis colli a. E. Omo-hyoid. F,R. Suprascapular a. G. Eighth cervical and dorsal root. H. Muscular branch. I. Subclavian v. J. Fifth root. K. Sixth root. L. Scalenus medius. M. Nerve to subclavius. N. Suprascapular n. S. Calvicle and subclavius. T. Pect. major. U. Ant. thoracic n.

After two weeks the fixed dressings may be discarded. Kennedy does not advise any special after-treatment, believing that the nervous impulses, which can now reach the muscles, will lead to their satisfactory development. Most surgeons will undoubtedly endeavor to assist recovery by the use of electrical stimulation and massage.

Harris and Low think that Kennedy relies too much on the physical appearance of the nerves when exposed, and as a consequence may be led to excise too much. Thus, if the deltoid, spinati, biceps, and brachialis anticus muscles

(and perhaps also the supinator longus) are paralyzed, and if Markoe's observation be remembered, then after exposing the nerves it would be wise separately to stimulate faradically the fifth and sixth nerves. If stimulation of the fifth fails to gain response while stimulation of the sixth does, then these observers advise that the fifth nerve be followed upwards, be divided well above the junction, and the proximal end of its peripheral portion be anastomosed to a splint in the side of the sixth nerve. Part of this advice does not appeal to the author, as there seems to be little advantage to be gained by it, in that the portion of the fifth nerve grafted on to the sixth has been proved to be incapable of conduction.

Undoubtedly Harris and Low are right in advising the use of electrical tests before excising portions of the nerve, as by this means nerve tissue may be saved which would otherwise be destroyed. The benefit of analytical observation during operation is shown by a case in which Harris and Low made use of cross-union. The case was one of atypical Duchenne-Erb palsy:

A girl, aged two years, had suffered a few months before from "infantile paralysis or acute anterior poliomyelitis of the right shoulder," leaving behind paralysis and wasting, with reaction of degeneration in the deltoid, supraspinatus, and infraspinatus muscles. The biceps, brachialis anticus, and supinator longus were only slightly affected. From dissections and experiments on monkeys Harris and Low concluded that the "circumflex" bundle of nerve filaments occupies the upper half of the fifth root. In the case under discussion they made a longitudinal split in the fifth root, found that the faradic stimulation of the upper segment of the nerve gave the very slightest contraction of the biceps with definite weak contractions of the deltoid and triceps, while stimulation of the lower half gave powerful contractions of the biceps, causing strong flexion of the forearm, with no contractions at all in the deltoid. This being so, the "upper half of the nerve was formed into a flap having its base below (at the junction of the fifth and sixth roots) and the free end of the flap was anastomosed to a split made in the side of the sixth root."

Operations such as this one of Harris and Low have not yet stood the test of time, but their possibility and plausibility make them deserving of attention. In one of his cases Kennedy had a most gratifying result.

(B) Indirect Method.—*Tubby's Operation.*—("Brit. Med. Jour.," Oct. 17, 1903.) In some cases satisfactorily treated by Tubby no attempt was made to repair the damaged nerves, but disability was relieved by means of muscle transplantation or grafting. The operation is performed in two sittings:

(*a*) *Restoration of Elbow Flexion.*—*Step* 1.—Make an incision four to six inches long, from the middle of the back of the upper arm downwards and forwards towards the front of the elbow, and following the course of the musculo-spiral groove.

Step 2.—Expose and draw aside the musculo-spiral nerve. Demonstrate the outer part of the triceps muscle which arises above and to the outer side of the musculo-spiral groove. Detach a wide strip of the outer part of the tri-

ceps from its tendon, and separate it upwards for three to four inches, leaving this strip or flap attached to the rest of the triceps by its upper extremity.

Step 3.—Through the same incision expose the lower end of the biceps. At a point about two inches above the elbow make a tunnel through the muscle, from behind forwards. Flex the elbow to relieve tension. Pull the free end of the triceps flap through the tunnel in the biceps and fix it there with sutures.

Step 4.—Close the wound. Dress. Immobilize the elbow in a position of flexion. Do not permit any attempts at motion for one month.

(*b*) *Restoration of Shoulder Abduction.*—*Step* 1.—From a point one inch below the middle of the clavicle make an incision outwards to the tip of the acromion and then downwards for three inches. From the tip of the acromion make an incision upwards for two to three inches. Reflect the flaps outlined.

Step 2.—Demonstrate the clavicular portion of the pectoralis major; separate it from its attachment to the rest of the muscle; divide its insertion into the humerus, thus forming a muscular flap attached to the clavicle. Demonstrate and divide the insertion of the trapezius into the clavicle; separate the corresponding part of the muscle from the rest of the trapezius by splitting in the direction of the fibres. Thus a second muscular flap is obtained.

Step 3.—Bring the free end of the flap obtained from the pectoralis major upwards over the acromion process and fix it into the deltoid. With sutures fix a few fibres of the pectoral flap to the tip of the acromion so as to avoid slipping. If the flap is not long enough to reach and be united to the deltoid satisfactorily, make a vertical incision through the muscle to the bone, reflect upwards a flap of periosteum (as thick and large as possible), and unite this to the end of the pectoral flap. Suture the end of the flap obtained from the trapezius to the side of the pectoral flap. The result is a new muscle composed of contributions from the pectoralis major and the trapezius, inserted into the humerus in imitation of the deltoid.

Step 4.—Close the wound. Dress. Immobilize in a position of abduction. Do not put the newly grafted muscle on stretch for at least a month. After one month begin exercises with caution. Tubby has had some excellent results from this operation.

In certain cases of deltoid paralysis, other than Duchenne's, muscle transplantation may be valuable.

Hildebrand's Operation.—Instead of changing the site of insertion Hildebrand has changed the site of origin of the pectoralis major.

Experiments have shown that a muscle which has been almost entirely cut off from the circulation may be united with the body again and retain its function *provided* that its connection with the central nervous system is retained and that the blood supply of these nerve connections is intact. It is true that the majority of the muscle fibres degenerate as a result of the sudden limitation of the circulation, but the power of regeneration is completely preserved. These experiments teach that preservation of the nerve supply is much more important than preservation of the vascular connections of a muscle used in transplantation. Hildebrand used the above knowledge in the following case:

A child, age four, suddenly became paralyzed in left shoulder fifteen months before.

Examination showed complete loss of function of the following muscles: Sterno-mastoid and trapezius (n. accessorius), deltoid and teres minor (n. axillaris), serratus anticus major (n. thoracicus longus), infraspinatus (n. suprascapularis). Flail joint. Arm hung loose, was rotated inwards and adducted.

Operation.—Step 1.—Make an incision through the skin from the sternal end of the fourth rib upwards to the sterno-clavicular joint, from here outwards immediately above the clavicle to the acromion and thence downwards over the bulge of the shoulder to a point near the insertion of the deltoid. Reflect

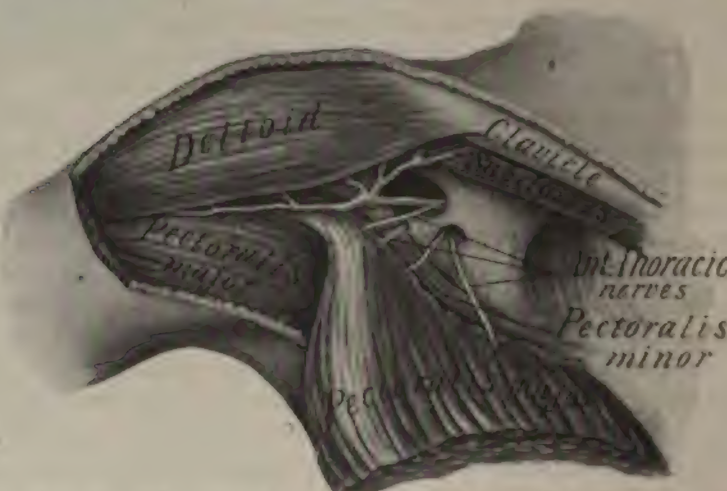


FIG. 898.—Transplantation of pectoralis major. (*Adapted from Zuckerkandl.*)

downwards the skin flap thus outlined, so as to expose the pectoralis major and the deltoid very freely.

Step 2.—Divide the sterno-clavicular origin of the pectoralis major through its tendinous portion, *i.e.*, close to the bone. Separate the muscle completely from the chest-wall. With utmost care preserve the anterior thoracic nerves and the accompanying vessels which come from under the clavicle above and enter the deep surface of the muscle (Fig. 898). The muscle is now merely attached to the body by its insertion into the humerus and by its vessels and nerves.

Step 3.—Turn the flaps upwards and outwards so as to cover part of the deltoid and suture the divided origin of the muscle to the outer third of the clavicle and to the acromion after preparing these bones by cutting a groove in them. The muscle now extends from the clavicle (outer one-third) and acromion over the apex of the shoulder to the crest of the greater tubercle of the humerus, *i.e.*, it is in position to elevate the arm.

Step 4.—Close the skin wound. Apply dressings. Fix the arm in the

horizontal posture (abduction) so as to relax the implanted muscle. At the end of six weeks the patient was able to bring the arm forwards nearly to the horizontal, and was able to touch her nose and the back of her neck. ("Archiv für klin. Chir.," lxxviii, 75.)

Hoffa's Operations.—Hoffa has devised measures similar to those of Tubby. His report ("Archiv für klin. Chir.," lxxxi, 473) is as follows:

1. A. M. 9. Right paralytic flail shoulder. Complete paralysis, deltoid.

Operation.—Separation of the trapezius from the clavicle, acromion and scapula. Union of the divided trapezius to the deltoid, the arm being com-

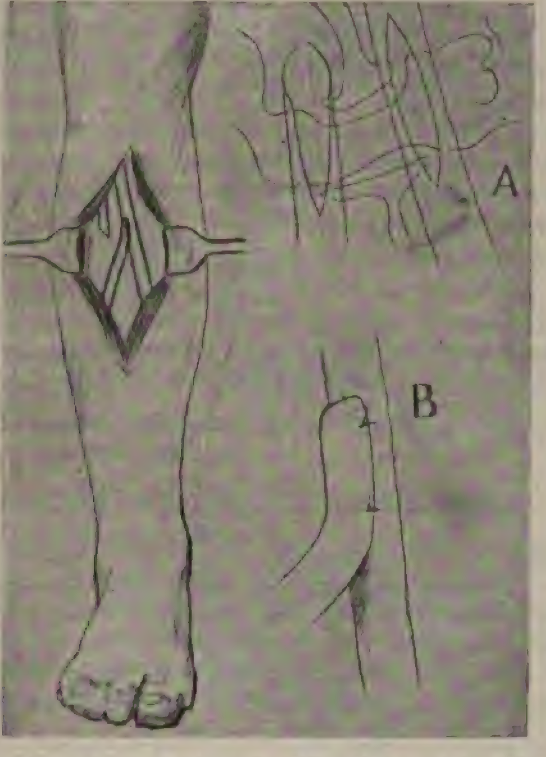


FIG. 899.—Nerve anastomosis. (*Murphy, Surg. Gyn. Obst.*)

pletely abducted. Result good. The patient can raise the arm almost to the horizontal, and the function is only slightly limited.

2. F. K. 2½. Obstetricial paralysis, right arm. Arm hangs loosely downwards; internal rotation so marked that the elbow points forwards.

Operation.—Division of the insertion of the very tense pectoralis major. Resection of a part of the head of the humerus. Transplantation of the trapezius into the deltoid. Result good. The internal rotation corrected; the arm can be raised nearly to the horizontal so that the hand is easily put to the mouth.

NERVE ANASTOMOSIS FOR THE CURE OF ANTERIOR POLIOMYELITIS

Author and publication	Condition and extent of paralysis	Operation	Result
Peckham. Providence Med. Jour., 1900, p. 5.	Anterior poliomyelitis; 10 years' standing.	Section of healthy fibres and anastomosis with diseased fibres.	Extension of toes 6 weeks later.
W. G. Spiller and Charles H. Frazier. Jour. Am. Med. Assn., Jan. 21, 1905.	(a) Paralysis of anterior tibial muscle (limited paralysis, anterior poliomyelitis). (b) Paralysis confined to the peroneal muscles; 2 years' standing.	Branches supplying tibial muscles rushed into musculocutaneous. Anastomosis between anterior tibial nerve and musculocutaneous.	(a) Gait nearly normal, and the child can draw up the inner side of foot almost with normal power. (b) No improvement after 4 weeks. No change in the electrical reaction.
James K. Young. Internat. Clinics, 14th ser., vol. iv, p. 159.	Paralysis, limited to anterior tibial muscle only.	Anastomosis between the branch supplying anterior tibial muscle and musculocutaneous by inserting the former into slit formed in the latter.	Improvement at time of presentation of patient.
John B. Murphy (present paper).	Paralysis limited to anterior tibial muscle and extensor communis digitorum; 5 years' standing.	Nerve anastomosis combined with tendon-plastic. (a) Anastomosis between external and internal popliteal. (b) Elongation of flexors, shortening of extensors.	Great improvement. Extension voluntary. Electrical response in extensors. Patient walks—runs.
Kader (Cracow, Poland.) Quoted in Chipault's actuel de la chirurgie nerveuse, vol. ii, p. 202.	Four cases of infantile paralysis with equinovarus (paralytic).	Anastomosis between external and internal popliteal; also tendon plastic, elongation of flexors and shortening of extensors.	One success; one failure, one improvement, one in convalescence at time of publication.
P. Hackenbruch (Wiesbaden). Proc. Germ. Surg. Cong., 1913, vol. xxxii, p. 238.	Infantile paralysis.	Implantation of one-third of tibial nerve into the peroneal nerve.	Some improvement at the time of communication.
John B. Murphy.	Infantile paralysis. Paralysis of peroneus tertius and brevis.	(a) Transplantation of two-fifths of tendo achillis into slit tendon of long and short peroneal. (b) Implantation of two-thirds of peroneal branch of musculocutaneous into anterior tibial.	Too early for muscular return.

III. *Nerve anastomosis for anterior poliomyelitis.* Since it has been shown that a paralyzed nerve which is functionally separated from its motor centre is still able to carry impulses if anastomosed with a functionally intact neighboring nerve, endeavors have been made by several surgeons to supply nerve stimuli to the muscles paralyzed as a result of anterior poliomyelitis, by means of nerve anastomosis. As very great and often unexpected recovery may take place after paralysis from anterior poliomyelitis it is usually considered wise to wait 6 months or more before deciding an operative interference.

Fig. 899 (Murphy) shows a good type of operation.

The preceding table compiled by Murphy shows what has been done by nerve anastomosis in infantile palsy.

IV. Dislocation of Ulnar Nerve at Elbow.—Momburg ("Archiv f. klin. Chir.," lxx, 215) has shown that the ulnar nerve is frequently thrown out of its groove on the inner epicondyle, especially during elbow flexion; that this is entirely unimportant unless the nerve is irritated; that when there are irritation and pain, the only cure is by operation. Several operations have given good results. Croft sutured the nerve to the triceps tendon and the fibrous tissue covering the bone. McCormac isolated the nerve and fixed it by loops of kangaroo tendon to the triceps tendon. Several surgeons have formed flaps of fascia or even of bone and periosteum (from the epicondyle) and with these covered the nerve in its groove. Momburg splits the triceps tendon and part of the muscle longitudinally; at the upper end of the split he divides the muscles to the ulnar side of the split, pulls the flap thus formed around the nerve, and sutures the muscle in its normal position. The nerve now passes through the triceps and cannot be dislocated.

ALTERATIVE OPERATIONS ON NERVES

The most important methods employed to modify the structure or condition of nerves are nerve-stretching and the disassociation of fibres. In the latter operation, after the nerve is exposed, its fibres are separated one from the other by blunt dissection; the indications and results are supposed to be similar to those of nerve-stretching, but the operation does not appeal to most surgeons. Nerve-stretching has been used in many affections. Its employment seems most valuable in neuritis (*e.g.*, sciatica), perforating ulcer of the foot, varicose ulcer (the ulcer being dystrophic, *i.e.*, due to a lack of nerve stimuli to the area affected), angio-neurotic changes in the lower extremity, muscular spasm *e.g.*, in facial region. Various explanations of the modus operandi of nerve-stretching have been given, the most reasonable being the breaking down of adhesions and the production of local hyperemia.

Sciatic Nerve.—The most suitable cases for nerve-stretching are those of sciatica due to exposure to cold and wet and in which the pain is limited to the distribution of the nerve.

The Operation.—Lay the patient in the prone position. Note by palpation the tuber ischii and the great trochanter, midway between these points make a 4-inch longitudinal incision downwards from a point just above the gluteal

fold. The centre of the cut corresponds to the lower edge of the gluteus maximus which is at a level lower than the fold of the buttock. Divide the fascia.

Demonstrate the edge of the gluteus maximus running downwards and outwards, and retract it upwards. Feel for and retract outwards the hamstring muscles after relaxing them by bending the knee.

The nerve is now exposed. Hook the nerve up with the finger and apply traction both upwards and downwards. The traction must be steady and strong. Enough power to lift the limb may commonly be exerted without danger, as the sciatic nerve can withstand a strain of about 80 pounds. Replace the nerve in its bed. Close the wound.

Internal Popliteal Nerve (Tibial Nerve).—*Step* 1.—From the centre of the popliteal space make a 3½ inch incision downwards over the interval between the two heads of the gastrocnemius. Retract the short saphenous vein and nerve. Divide the deep fascia.

Step 2.—Separate the two heads of the gastrocnemius. Flex the knee to relieve tension. Follow the short saphenous vein into the popliteal space; it goes directly to the popliteal vessels, superficial to which the nerve lies.

Step 3.—Hook up the nerve with the finger. Stretch it by pulling upwards and downwards.

External Popliteal Nerve (Peroneal).—Treves thus describes the exposure of this nerve:

"*Anatomy.*—The external popliteal or peroneal nerve follows the outer side of the popliteal space, lying close to the biceps. Passing over the outer head of the gastrocnemius, between it and the biceps, the nerve reaches the neck of the fibula, and crosses that bone beneath the fibres of the peroneus longus muscle. The nerve may be easily felt, when the knee is a little flexed, as a loose rounded cord, lying just behind the biceps, as it nears the head of the fibula.

"*Operation.*—The patient lies upon the sound side, with a sufficient tending to the prone position to well expose the outer aspect of the knee. The knee-joint is extended. An incision, one inch and a half in length, is made parallel with and immediately posterior to the tendon of the biceps. The cut should be so placed that its upper half is in relation with the tendon while its lower half is over the fibula. The skin and deep fascia having been divided, the biceps tendon is exposed. The knee should now be a little flexed and the nerve sought, close to the point at which the tendon reaches the head of the fibula. A narrow and unduly prominent ilio-tibial band has been mistaken for the biceps tendon."

Facial Nerve.—The facial nerve has been successfully stretched in the treatment of spasmodic tic. This operation is highly recommended by Kocher. Exposure of the facial nerve is sufficiently described in the chapter on nerve anastomosis.

Exposure of Musculo-spiral (Radial) Nerve.—This nerve requires exposure and treatment, in most instances, because of injury or compression due to fracture of the humerus.

ɔsure of Nerve in Lower Part of Upper Arm.—*Step* 1.—Make an oblique about 3 inches long in the groove between the supinator longus and lis anticus muscles. The whole of this incision is in the lower third ırm. Divide the deep fascia. Separate the two muscles (sup. longus; lis ant.) and expose the nerve which lies between them.

2.—Follow the nerve upwards to the site of injury being careful not e the companion artery. In a case operated on by the author the nerve etched as a thin fibrous band sharp angle of bone for a e of about ¼ inch. All ob-ble pieces of bone were cut the nerve which was ad-to the bone was freed; a brachialis anticus muscle tched between the nerve bone and the wound closed. sult was perfect after some of appropriate treatment.

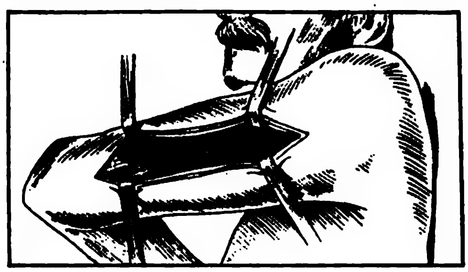
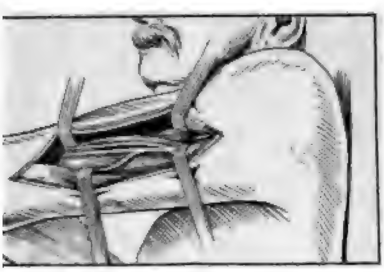


FIG. 900.—(*Schwartz and Kuss.*)

ny reason it is impossible or improper to find the nerve below the site y, expose it above.

ɔsure of Nerve in Upper or Middle Part of Arm.—From a point a little ıan the posterior axillary fold make an incision downwards over the ce between the long head and the external (lateral) head of the triceps. e the two heads of the muscle by blunt dissection down to the bone which the nerve lies accompanied by the profunda artery.



IG. 901.—(*Schwartz and Kuss.*)

Schwartz and Küss ("Revue de Chir.," No. 6, 1912) point out that the classical high exposure of the musculo-spiral nerve gives access to a very limited portion of it and gives no opportunity to follow the nerve downwards, while to expose the nerve low down and follow it upwards does much damage to muscle and to nerve branches. They advise the following operation:

1.—Place the patient on his back; hold the arm vertically but slightly d; hold the forearm in a position of pronation and at right angles to the that the hand rests on the chest inside the opposite axilla. Draw an ry line from the tip of the olecranon *exactly* in the middle line of the r surface of the arm to the prominent posterior border of the deltoid.

2.—Make an incision through the skin along the imaginary line from four fingerbreadths below the tip of the olecranon downwards for from 3 cm. according to the supposed site of nerve lesion. Cut through the neous tissue and expose the deep fascia.

Step 3.—Carefully incise the brachial aponeurosis throughout the whole length of the wound and retract the edges of the aponeurotic wound. Note that in the distal part of the wound on the ulnar side of the median line there

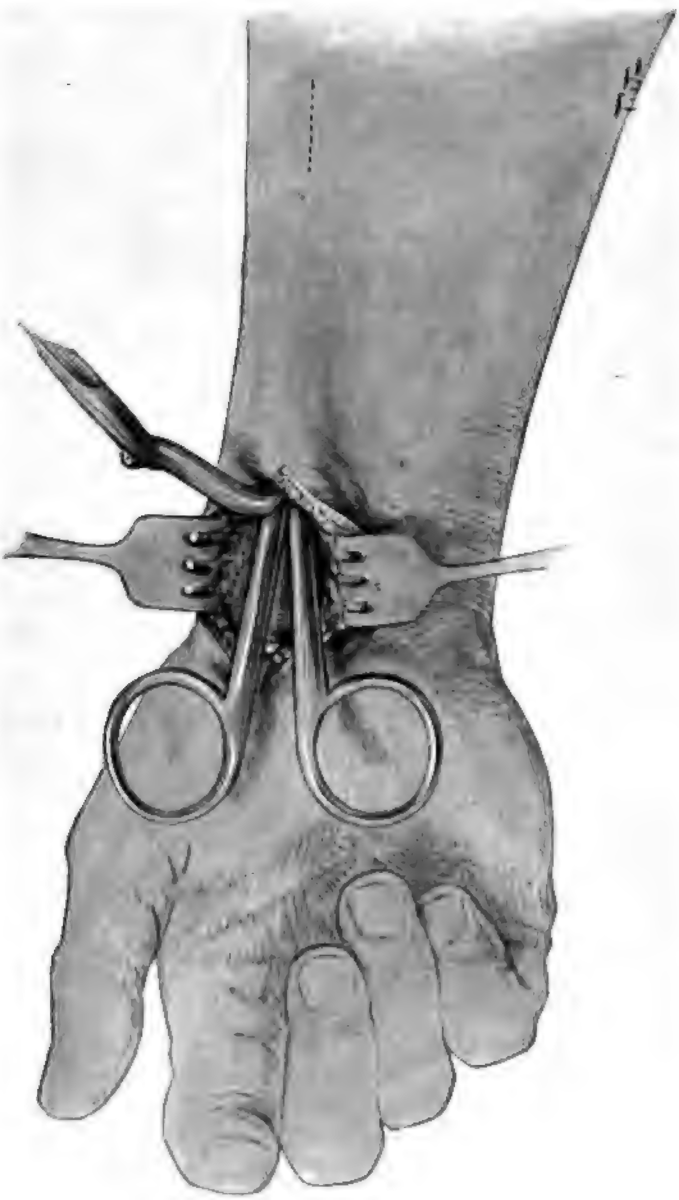


FIG. 902.—**Tenoplasty.**

Shows the tendon of the flexor carpi radialis after division just below the annular ligament and elevated. The blunt scissors is passed upward a distance of four inches beneath the skin and on the muscle tendon. It is spread as it is passed. The dotted line indicates the position in which the skin is to be incised and where the end of the tendon is to be drawn out.

is a V-shaped strip of tendon (tendon of the long triceps). The radial border of this V of tendon lies exactly along the olecrano-deltoid line described in Step 1 (Fig. 900).

FIG. 903.—**Tenoplasty.**

Shows the tendon drawn out in order to pass it over the brachioradialis and beneath the skin, and give it the proper angle for forceful contraction as an extensor muscle.

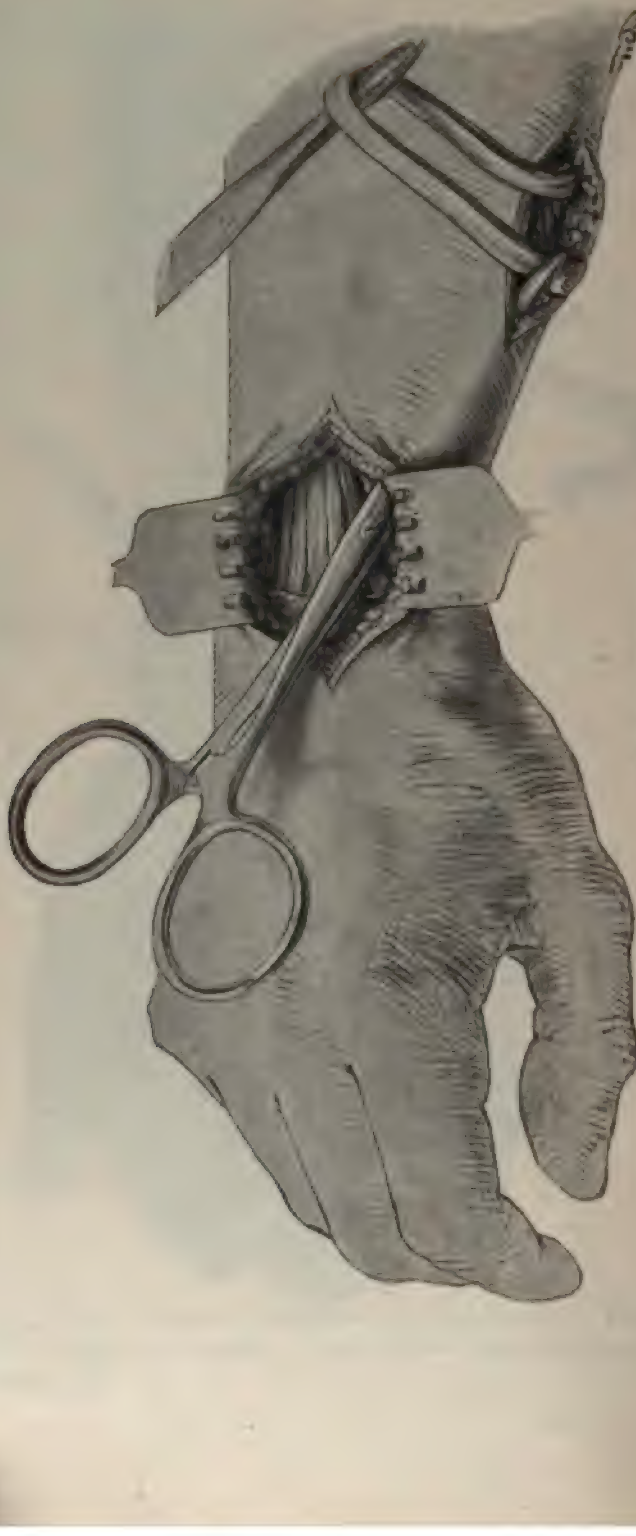


Fig. 904.—Tenoplasty.

Shows the incision on the dorsum of the band over the extensor tendons with the forceps passing beneath the fascia and fat, and grasping the end of the flexor carpi radialis tendon.

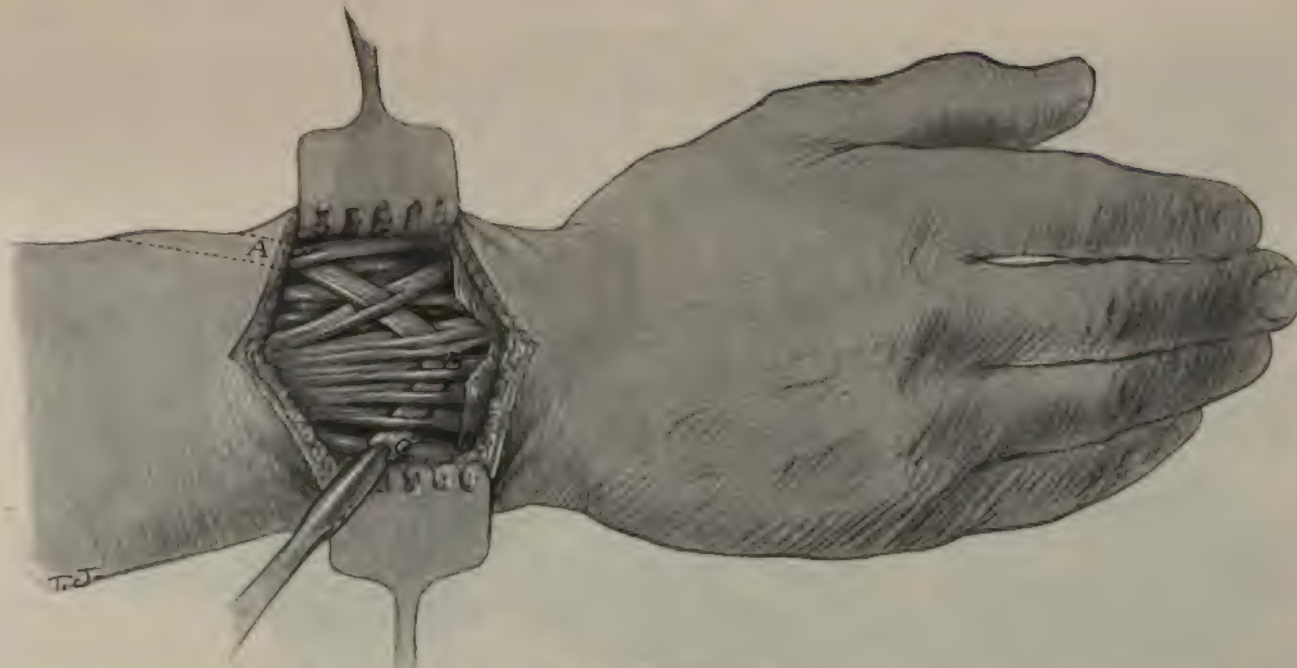


FIG. 905.—Tenoplasty.

Shows the tendon of the flexor carpi radialis as it passes through the transfixed extensor longus and brevis pollicis, the two extensor tendons of the ndex-finger, and the extensor tendons of each of the remaining fingers, the line from *A* to *B* being only slightly deviated from the direct traction line of the tendon, so that the primary contraction of the tendon extends the index-finger and the thumb. The tendon from *B* to *C* is at right angles to the portion of the tendon from *A* to *B*, so that the index-finger and thumb may be used continuously extended and contracted without extending the middle, ring, or little fingers. When full contraction and full extension are made, then all five fingers are extended. One cannot extend the little or ring finger without extending the other three. One can extend and flex the thumb and index-finger without moving the other three.

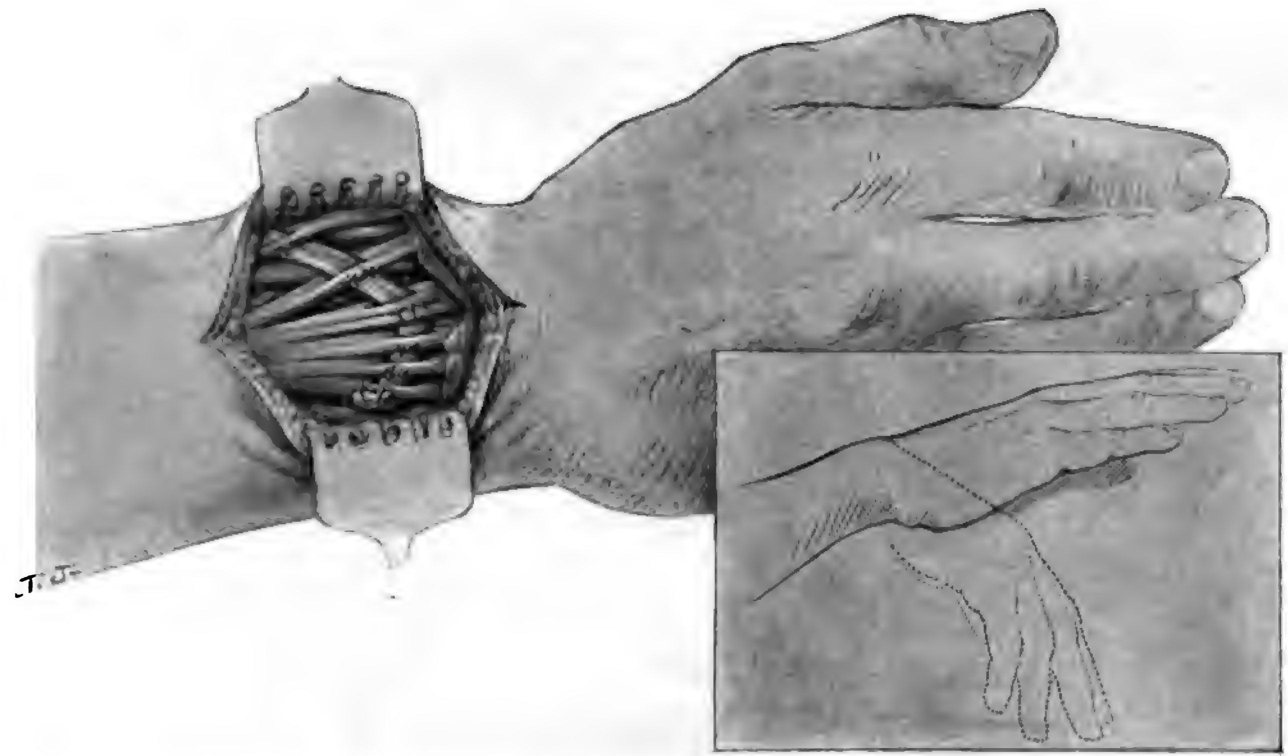


Fig. 906.—Tenoplasty.

Shows the sutures as placed in the extensor tendons, fixing them to the tendon of the flexor carpi radialis, so that they become an integral part of it. The insert shows the practical effect on the hand at the end of the third day after operation. The patient had full extension of all his fingers and the thumb, and he could extend the index-finger and thumb without extending any of the three other fingers.

ep 4.—Incise or split the muscular fibres along the radial border of the aped tendon between it and a quadrilateral layer of tendon (tendon of nal head of the triceps) which does not extend so far up the arm (Fig. 900). s soon as the tendinous tissue is carefully divided in the distal angle of the tive field a sort of muscular interstice is found lying between the outer of the triceps (on the radial side) and the long head of the triceps (on the side). If the incision or the dissociation of muscular fibres is kept rigor- in the median line, as soon as the whole thickness of the triceps is pene- a yellowish-white fascia presents, the thickness and consistence of which This fascia binds the musculo-spiral nerve and its accompanying vessels humerus (Fig. 901).

p 5.—Carefully divide the fascia and so expose the nerve from the axilla re it penetrates the external intermuscular septum to reach the anterior the arm.

sometimes happens that the ends of the divided nerve cannot be found , after fracture of the external condyle, there may be such a mass of pressing on the nerve that restoration of conduction seems too difficult ossible—under such circumstances tendon transplantation may restore n.

the International Surgical Congress in 1914, J. B. Murphy exhibited nt who had suffered from the effects of division of the musculo-spiral Murphy to make the demonstration more striking "handled the truth carelessly" describing the treatment as if it had been neurorrhaphy. sult was accepted as excellent. He then confessed the excusable "pious and explained what really had been done. The Figs. 902, 903, 904, d 906, with their legends clearly describe the operation. After suture of perficial fascia and fat to prevent union between the tendons and skin, in wound is closed and the hand immobilized in extreme extension nion occurs. Complete restoration of function may be expected in four —an enormous saving of time as compared with the year which must before recovery after nerve suture. (Murphy.)

CHAPTER LXI

ARTERIORRHAPHY

The subject of arterial suture is old. Hallowell and Lambert, in 1759, closed a small wound of the brachial artery by passing a pin through the edges of the wound and winding a thread round it as in the old hare-lip operation. Though born so long ago, arteriorrhaphy has only recently begun to grow, and even at present is, in many respects, merely in the experimental stage. The subject is so important, so many procedures are being transferred from the physiological laboratory to the operating-room, and it so often happens that in an emergency one wishes knowledge so to the possibilities and methods of arteriorrhaphy that the writer deems it wise to introduce a chapter dealing with it at this place.

For success in arterial suture the following things are essential: (1) *Perfect* asepsis. (2) A clean-cut wound. (3) Absence of tension on the sutures. (4) No rough handling of the vessel. (5) An efficient and *non*-injurious method of obtaining temporary hemostasis. (6) Good suture material.

Suture Material.—For a time catgut was the favorite material because when in site it became swollen and so filled the needle punctures that hemorrhage was prevented. The use of fine needles, without cutting edges (intestinal or seamstress' needles) seems to prevent hemorrhage sufficiently. To-day very fine silk is the suture of choice, probably v. Braun's celluloid hemp would be as good, but the familiar Pagenstecher's linen is too rough, theoretically at least. Carrel finds it most important to impregnate the suture thoroughly with sterile vaseline so as to prevent the deposit of blood-clot on the thread. This lubrication of the thread, a trifle though it may seem, is probably the cause of the recent wonderful advances and successes in experimental arterial surgery. The needles used are fine round needles (intestinal, cambric, seamstress') which may be straight or curved. Carrel uses No. 15 or 16 needles. For sutures he formerly procured the finest silk thread possible, untwisted it and used one of the strands of which it was composed, this delicate strand constituted the suture after it had been impregnated with sterile vaseline. He now obtains silk of suitable fineness from Lyons.

Lilienthal uses No. 12 needles and No. 000 silk. Dorrance uses No. 1 Pagenstecher thread on the finest needle the thread will pass through.

METHOD OF TEMPORARY HEMOSTASIS

In a few cases the elastic constrictor may be used, in most cases its use must render the operation unnecessarily difficult or be distinctly harmful.

An assistant's fingers may be applied to the vessel above and below site of wound, but while such form the safest clamps yet they get in the way and are not so practicable as mechanical appliances.

Clamps.—Clamps the blades of which are covered with rubber tubing are serviceable. The best-known clamps are: (*a*) Broad-bladed, delicate, eight-inch Billroth forceps (Murphy). (*b*) Miniature Doyen hysterectomy clamps (Dorrance) (Fig. 907). (*c*) Ordinary hemostats (Kümmel.) (*d*) Herrick's clamp (Sweet). (*e*) Crile's clamp (Fig. 908).

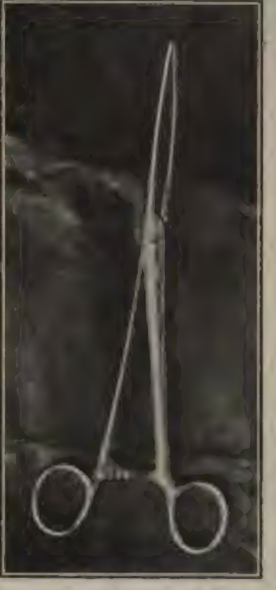


FIG. 907.—Dorrance clamp.

Tapes, etc.—Fine linen strips thrown around the vessel and fastened by forceps instead of by a knot (Carrel and Guthrie). Fine, thin tape fastened by forceps or serre-fins (Lilienthal). Heavy twisted silk used in the same manner.

Whatever means of hemostasis is used, it must be used most gently. The forceps or tape must only exert enough pressure to control the circulation and not one iota more. Crushing or injury to the intima is fatal to success.

SUTURE OF ARTERIES

Temporarily occlude the artery about 1 inch above and below the wound with clamps or tapes. Gently but thoroughly remove all blood whether clotted or not; in doing this use the normal salt solution. Examine the edges of the wound; if they are lacerated or contused pare them. For this purpose Carrel uses fine scissors. Coat the vessel both inside and out with vaseline (Carrel). Carefully resect or remove the external sheath of the vessel from the neighborhood of the wound. If any fibres of this fibrous tissue tunic get between the edges of the wound and into contact with the blood, a thrombus will quickly form. The easiest method of resect-

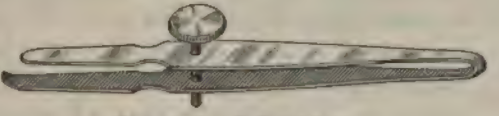


FIG. 908.—Crile's clamp.

ing the outer coat is to pull it forwards over the inner coat and clip it off with scissors (Fig. 909).

Methods of Suture.—Interrupted or continuous sutures may be chosen at the option of the operator; the continuous suture is the favorite.

Method A.—Pass the suture as in Fig. 910 without damaging the intima. This is possible in large arteries, but impossible in medium-sized ones or in veins. The disadvantages of the method are the limitations of its applicability;

its difficulty; the possibility of fibrin ferment passing from the arterial walls to the blood-stream; the possible presence of fringes of intima hanging into the blood-stream and favoring coagulation and the possibility of blood passing through the open intima, infiltrating the vessel-wall, thus causing aneurysm.

Method B. Through-and-Through Sutures.—Close the wound by sutures penetrating all the coats of the vessel, taking care "not to include fragments of the connective-tissue layer in the line of suturing, and to obtain a smooth union and approximation of the endothelial coats" (Carrel).

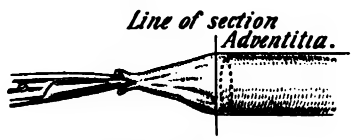


FIG. 909.

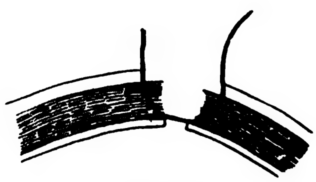


FIG. 910.

Figs. 911 and 912 are self-explanatory. During the passage of the sutures the extreme edges of the wound may be held in delicate dissecting forceps. A thimble is useful in pushing the needle through the tissues. This method has given many excellent results. The line of union may be strengthened by separate suture of the adventitia.

Method C. Brieau-Jaboulay Suture.—This suture is highly commended by Archibald Smith, and a practically identical stitch has been advised by Dorrance.

The suture produces eversion of the lips of the wound and brings intima into contact with intima. *Prima facie* one would think such a suture would produce stenosis, but A. Smith's researches show that such is not the case.

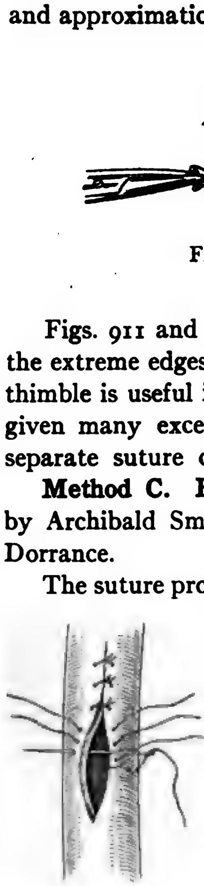


FIG. 911.

Pass a stitch from without inwards through all the coats of the wounded vessel at the point a (Fig. 913); pass the same thread from within outwards through all the coats of the opposite side of the wound at the corresponding point b. Reintroduce the stitch from without inwards at c, and complete its course by bringing it from within outwards through the whole thickness of the vessel-wall at d. This leaves in place a U-suture which everts the lips of the wound. In a short wound or puncture one U-suture may suffice; in a longer wound several will be necessary, each tied separately or placed in a continuous fashion.

Method D. Brewer's Adhesive Plaster.—George Brewer, having had ill results from arterial sutures failing to hold, has wrapped wounded vessels with an "elastic plaster made up of a strip of very thin gum (rubber), coated with an adhesive material like that used in the zinc oxide plaster. Experiments were made on a large number of animals and some of the results were good." The

method does not seem to have been used in practice. The objections to the method are: Difficulty in applying the plaster with sufficient and not too much tension; the almost certain absence of the material when it is required; a foreign body being left in the wound.

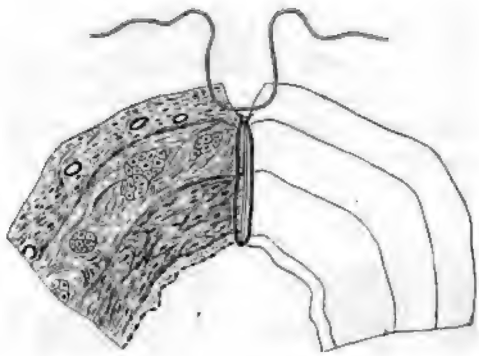


FIG. 912.—Arterial suture.

END-TO-END ARTERIAL ANASTOMOSIS

Circular arteriorrhaphy is of value when an artery of size has been completely divided or a portion of it has been excised. The same general rules laid down for suture of arterial wounds apply to the operation about to be described.

Sweet prepares the divided ends of the vessel for suture by carefully removing the loose connective-tissue sheath (adventitia) about the ends of the vessel (Fig. 909). "This can be done very nicely by grasping the sheath with forceps, drawing it over the end of the vessel and clipping it off with scissors." During the operation keep the vessels from drying either by moistening with salt solution or by applying sterile vaseline. When the suture is complete and the blood

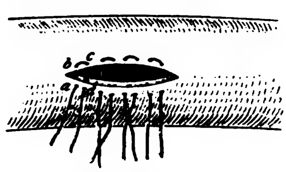


FIG. 913.

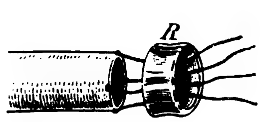


FIG. 914.

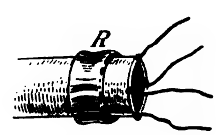


FIG. 915.

FIGS. 914 AND 915.—Payr's magnesium rings.

allowed to resume its circulation there is rarely any bleeding, and such as there is is easily controlled by temporary pressure.

Payr's Method.—*Magnesium Prosthesis.*—Have at hand a number of rings grooved on their outer surface, of different sizes and made of very thin magnesium.

Step 1.—To the cut edges of the central segment of artery apply four fine silk sutures penetrating all the coats of the vessel (Fig. 914).

Step 2.—Choose a ring which will fit accurately round the artery. Pass

the four threads through the ring (Fig. 914). With the threads pull the artery through the ring until an amount of artery protrudes from the ring rather greater than the width of the ring (Fig. 915).

Step 3.—Aided by the threads, turn the protruding cuff of artery backwards over the ring and fix it in place by tying a fine ligature round it (Fig. 916). The groove in the ring prevents the ligature from slipping.

Step 4.—Introduce four sutures into the cut edge of the peripheral segment (Fig. 917).

Step 5.—Make traction on these four threads and so distend the lumen of the peripheral segment (Fig. 916). Push the central segment (with its rings)

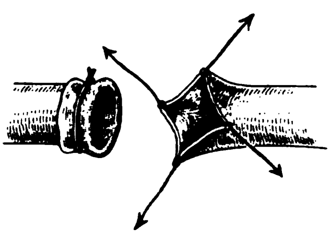


FIG. 916.

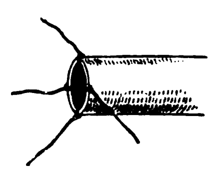


FIG. 917.

FIGS. 916 AND 917.—Payr's magnesium rings.

into the distended peripheral segment. When the peripheral segment covers the ring, fix it in place with a ligature (Fig. 918).

This completes the operation. It will be seen that the ring, though buried, is extra-vascular. Magnesium is dissolved and absorbed in the body, hence no persistent foreign substance is left in the wound. (Payr, "Archiv für klin. Chir.," lxii, 1; lxiv, 3; lxxii, 1.)

Murphy's Method.—*Invagination.*—*Step* 1.—Introduce a fine cambric needle, armed with fine silk, through all the tunics of the distal segment of the

FIG. 918.—Payr's magnesium

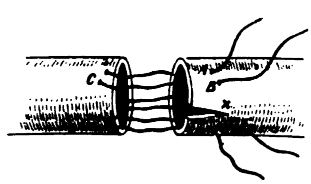


FIG. 919.

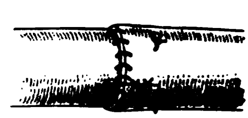


FIG. 920.

FIGS. 919 AND 920.—Murphy's method.

vessel from without inwards at the point A about ⅛ inch distant from the divided edge of the vessel (Fig. 919). Bring the needle out through the open end of the vessel. With the needle pick up a small portion of the adventitia and media (not the intima) at the point C, near the cut edge of the *proximal* segment of vessel. Introduce the same needle through open lumen of the peripheral segment and make it penetrate, from within outwards, the whole thickness of the vessel at a point close to A. The result of this is a U or mattress suture.

Introduce two other sutures in the same manner so that three **U**-stitches are in position at equal distances from each other.

Step 2.—Pull on the three **U**-sutures and so invaginate the proximal into the distal segment of vessel (Fig. 920). Tie the sutures. Before invaginating it may be necessary to make a slight longitudinal split (x) in the receiving or distal segment.

Step 3.—With fine sutures unite the edge of the distal to the side of the proximal segment at the line where the former overlaps the latter. If a longitudinal split has been made, close it also with a stitch.

FIG. 921.—(*Dorrance.*)

FIG. 922.—(*Dorrance.*)

Step 4.—Carefully suture any available tissues near the vessel in such fashion as to give the maximum of support to it.

Eversion Method. Brieau and Jaboulay's Sutures Modified by Dorrance.—"The clamps are applied as before.* The cut edges of the artery are grasped with dissecting forceps, and the suture is passed through the upper edge of the artery from without in and through the lower end from within out; the needle is then reversed and brought back 1.5 mm. to one side of the former suture and tied. (This suture is really a single mattress suture.) The suture is continued as a continuous mattress suture, dropping back half a stitch every third suture until the starting-point is reached; then a half stitch is made and the suture continued back as a whip-stitch until the starting-point is reached again; then the

* The clamps used by Dorrance are miniature copies of Doyen's hysterectomy clamp.

two ends are tied (Figs. 921 and 922). The suture is started on the anterior surface near the handles of the clamps. When the suture reaches the farther side of the artery the handles of the clamps are taken from the lower portion of the wound and placed in the upper portion. In this way the surface of the artery which was anterior is now posterior, and the suture can always be kept in sight."

Carrel's Method.—*Step* 1.—Introduce three tension sutures of very fine silk impregnated with vaseline at equidistant points of the circumference of the vessel ends (Fig. 923).* These sutures penetrate the whole thickness of the vessel-walls.

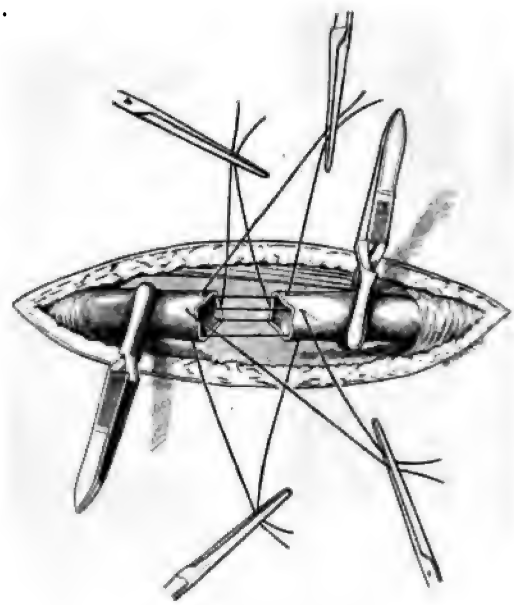


FIG. 923.—(*Carrel.*)

Step 2.—Have an assistant apply traction to two of these sutures so as to stretch the portion between the two sutures into a straight line and to approximate the corresponding cut edges of the vessel. Apply a hemostat to the third tension suture and let it hang so as to pull on the suture. The slight pulling on the three sutures arranges the circumference of the vessel as a triangle, and this facilitates suturing.

Step 3.—Introduce a continuous overhand stitch through all the coats all round the vessel. The stitches should be very close together and only drawn tightly enough to secure approximation, but not tightly enough to produce eversion of the edges of the wound (Fig. 924).

Step 4.—Remove the distal clamp (used for provisional hemostasis). Remove the proximal clamp. If there is any bleeding, gentle finger pressure will

* In the illustration four tension sutures have been employed.

t always stop it (Fig. 925). If necessary for hemostasis, introduce one or iterrupted sutures.

:p 5.—Close the wound after putting one or two stitches in the adventitia nforce the main arterial suture.

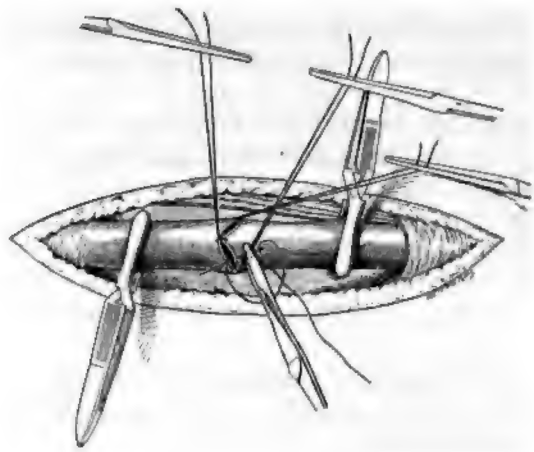


Fig. 924.—(*Carrel.*)

VENOUS IMPLANTATION

hen the severed ends of the artery are so distant that approximation is sible one may bridge the defect by implanting a segment of vein. E. ("Archiv für klin. Chir.," lxxxiii, 459) reports a case of axillary aneurysm he excised; approximation of the ends of the artery being impossible, he d a branchless segment of the great saphenous vein, united its distal end proximal segment of artery and its proximal end to the distal portion of

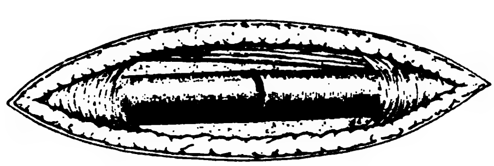


Fig. 925.—(*Carrel.*)

. The union was effected after Carrel's method. There was no hemor- and no thrombosis at the line of suture. The segment of vein seemed to ell. Experiments have shown that veins when substituted for arteries e thickened, stronger, and adapt themselves to their new duties.

me of Carrel's experiments on dogs and cats show admirably the possi- s of operations on the vascular system. At the Rockefeller Institute, York, Carrel exhibited to the members of the Society of Clinical Surgery y looking animals on which the following operations had been performed: ccision of segment of abdominal aorta, a corresponding segment of vena

cava being inserted to take its place. (*b*) Excision of segment of abdominal aorta, a corresponding segment of an aorta which had been kept in cold storage for some days being implanted into the gap. (*c*) Double nephrectomy—both kidneys being replanted. On suture of the vessels and ureters secretion of urine quickly manifested itself. (*d*) Amputation of the thigh of a black dog—implantation of the corresponding amputated thigh of a white dog on to the stump. When exhibited healing was not complete, but circulation was established in the implanted thigh.

Some of the operations described in the preceding paragraphs almost appear as if they were the offspring of a superheated imagination, but many of them have been applied in surgery with most conservative and gratifying results. It may be well and encouraging to briefly note a few cases in which the methods devised after animal experimentation have been applied to man.

Frank T. Stewart ("Annals of Surg.," July, 1908) reports two cases of resection of the brachial artery, one by the Murphy method with probable thrombosis, the other by Carrel's method with success.

Kümmel, during an operation for malignant disease, excised about 1¾ inches of the femoral artery. He successfully repaired the vessel by invaginating the central into the peripheral end.

E. Martin ("Med. Klinik.," 1908, No. 38) performed circular arteriorrhaphy (Carrel's method) after resection of 1¼ inches of the brachial artery injured by a trauma near the elbow. After union a slight murmur was audible over the scar.

Braun ("Archiv für klin. Chir.," lxxxvi, 707), while removing a retroperitoneal tumor, made an oblique tear in the aorta. The tear involved about half the circumference of the vessel, the walls of which had been thinned from pressure by the tumor. In anticipation of injuring the aorta the vessel had been provisionally compressed. Suture of the wound by a single layer of stitches was insufficient to prevent bleeding, and a second row when introduced produced too much stenosis (absence of femoral pulse, coldness of limbs), so Braun excised the injured segment of aorta and united the cut ends by Carrel's method. A small iodoform gauze tampon was placed against the line of suture and the abdominal wound closed around the tampon. The tampon was removed on the eighth day. The patient was confined to bed for four weeks. Three months later the patient was well.

TREATMENT OF THROMBOSIS AND EMBOLISM BY OPERATIONS ON THE VESSELS

It is necessary to distinguish between closure of an artery by a clot forming on an injured or diseased intima and closure due to an embolus lodging in a more or less healthy artery. In the first case removal of the blood-clot alone is valueless, as another clot will form immediately. If the injured or diseased portion of vessel is of a very limited extent, that portion may be excised and the divided ends of the vessel united by arteriorrhaphy or by the implantation of a

segment of vein. If venous implantation is attempted do not use the companion vein to supply the defect; this would be calculated to seriously interfere with the return circulation. Probably in thrombosis it may be better to send blood down into the limb through a vein (reversal of circulation), as will be described later. When the closure of the artery is due to the lodgment of an embolus, it is logical to open the vessel by a longitudinal incision after providing for temporary hemostasis, extract the clot, wash the interior of the segment of vessel segregated by the hemostatic tapes or clips with salt solution, smear it with sterile vaseline and close the wound with sutures. Frank Stewart reports an unsuccessful case of such an operation ("Annals of Surg.," Sept., 1907). To be successful it is necessary that the diagnosis of obstruction by embolism be made early and operation be promptly carried out. Of course the procedures mentioned are not at all established, but it is necessary for operating surgeons to bear them in mind. Instead of attacking arterial obstruction directly the surgeon may to some extent reverse the circulation in the limb and so dodge the impediment.

Bauer ("Zent. f. Chir.," xx, Dec., 1913) reports the case of a man aged thirty who experienced a sudden severe pain in both legs with complete loss of function. The limbs became blue and cold. After the lapse of three hours the abdomen was opened and the aorta was found pulseless at the level of its bifurcation. A clot having two short prolongations into the iliac vessels was removed by arteriotomy from the aorta and the vessel was closed by suture. The circulation was established satisfactorily and the patient went home on the twenty-fifth day.

J. C. Hubbard ("Annals Surg.," Oct., 1906, and Sept., 1907), in a case of gangrene of the foot, isolated the femoral artery and vein at the apex of Scarpa's triangle below the origin of the profunda and divided them after providing for temporary hemostasis. He invaginated the upper end of the artery into the lower end of the vein as in Murphy's method of arteriorrhaphy. After the operation there was no œdema, dilatation of the veins, or cyanosis. The gangrene present before operation spread a little and then a line of demarcation formed. When the foot was later amputated at the point of election on the tibia, both tibial arteries contained arterial blood. The stump healed satisfactorily but slowly. Hubbard writes: "It seems that the arterio-venous anastomosis must have increased in some way the amount of blood in the leg, for it is hard to believe that an amount of blood so small as to permit gangrene of the foot would be sufficient to nourish for ten months an amputation stump made only a short distance above the gangrenous area, and had thrombi formed at the sites of the anastomosis, it seems most probable that the gangrene would have extended up the leg instead of remaining localized."

Doberauer reports a case of embolism of the right axillary artery. The trouble had lasted fifty-two hours, and there was already present a commencing gangrene and ischæmic contracture of the limb.

Doberauer performed arteriotomy, removed a clot about 3 cm. in length and sutured the artery. A new clot formed in a few hours and was removed in the

same manner. Once more the thrombus reformed and after two days the gangrene notably progressed.

Arterio-venous anastomosis was now made between the axillary artery and vein. As soon as the anastomosis was completed and the blood current permitted to flow, "one perceived the eruption of the arterial blood into the vein in the form of a little explosion and one saw the blood advance to the level of the wrist." The vein pulsated like an artery. Twelve days after operation the circulation remained good.

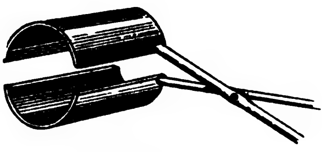


FIG. 926.

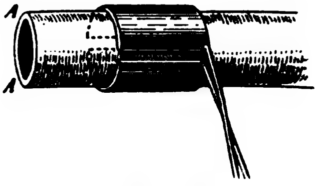


FIG. 927.

FIGS. 926 AND 927.—Murphy's anastomosis forceps. *A A.* Cut edge of vein.

In a patient who had lost his left leg from gangrene due to arterial sclerosis, marked symptoms of the same affection appeared in the remaining lower limb. Wieting Pasha exposed the femoral artery and vein at the apex of Scarpa's triangle, divided the artery completely, and introduced its central portion into the femoral vein for a distance of at least ⅜ inch (1 cm.) through an incision made on the anterior surface of the vein. The union was effected by sutures which penetrated the whole thickness of the wall of the vein but only the outer coats of the artery. The vein was ligated above the point of anastomosis. The foot soon became warm and rosy. Two months after the operation the circulation remained satisfactory ("Deutsche med. Woch.," 1908, No. 28).

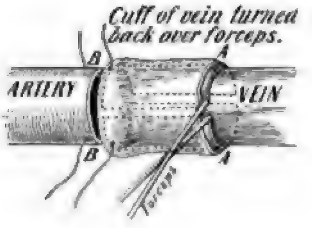


FIG. 928.
B B. Sutures through cut edge of artery and folded edge of vein.

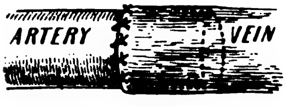


FIG. 929.

In October, 1908, J. B. Murphy exhibited to the Society of Clinical Surgery a patient in whom he had successfully established arterial circulation through the femoral vein for gangrene of the foot due to endarteritis. He operated as follows:

(1) Exposure of the femoral artery and vein and division of both. (Divide the vein at a slightly higher level than the artery.)

(2) Apply forceps (Fig. 926) around the distal segment of the vein near its end (A, Fig. 927). Pull the open end of the vein back over the forceps (Fig. 928)

...ment of the divided artery to the ...forceps (B, Fig. 928).

... the line of suture (Fig. 929) and ...

... that it would have been better to ... the artery and vein and then to have ...mosis; by so doing it would have been ...he stenosed artery while arterial blood ...deficiency created by the narrowing of

...912) has collected 52 cases of arterio- ... (30 per cent.) were successful, the ...tually saving the limb from present or

CHAPTER LXII

ANEURYSM

A short discussion of the forms and varieties of aneurysm may be of benefit as clarifying the consideration of their treatment. While trauma is an important cause of aneurysm, *e.g.*, gun-shot wound causing arterio-venous aneurysm, yet a weakening of the arterial wall from disease is by far the most common cause of the trouble.

(A) When an artery ruptures, whether from trauma, disease, or both, bleeding into the surrounding tissues takes place, resulting in a hematoma. If the wound in the vessel heals there may be no further trouble; if the wound does not heal and if from pressure, etc., the tissues surrounding the effused blood become condensed so as to form a capsule, then a pulsating, well-defined tumor is formed, the cavity of which communicates directly with the lumen of the wounded artery. This pulsating tumor is known as a *false aneurysm*.

(B) When an artery and a vein lying alongside each other are simultaneously wounded and the wound is treated by compression, the two vessels may adhere; the superficial wound may heal; the openings into the vessels may not close, but may form an arterio-venous anastomosis, the arterial blood passing directly into the vein. This condition is known as an *aneurysmal varix* and may or may not occasion any trouble. Instead of adhering one to the other, the artery and vein may each bleed into the surrounding tissues and give rise to a false aneurysm which communicates directly with the lumen of each vessel, so that the arterial blood passes from the artery to the vein through the intermediate sac. This condition is known as a *varicose aneurysm* and is of more moment than aneurysmal varix. The two varieties, viz., varicose aneurysm and aneurysmal varix, have the common name *arterio-venous aneurysm*.

(C) **Cirsoid aneurysm** is a condition in which a number of dilated arteries, held together by connective tissue, form a tumor which is the arterial equivalent of the venous varicocele. The disease is most common in the scalp, and its treatment is very similar to that of angioma.

(D) **True Aneurysm.**

1. When disease (*e.g.*, atheroma) weakens the whole circumference of an artery, dilatation is liable to take place (Fig. 930, 8, 9, 10). The whole circumference being affected, the dilatation is uniformly fusiform except in so far as it is affected by surrounding supporting structures (Fig. 930, 11, 12, 13). This is a *fusiform aneurysm*.

2. When disease weakens a *limited portion of the circumference* of an artery, a pouching of the arterial wall outwards is liable to take place, just as a bulging

or pouting of a pneumatic tire forms when a limited portion of the tire has become weakened (Fig. 930, 1, 2, 3, 4, 5, 6, 7). In this manner a larger or smaller sac is formed communicating with the lumen through a more or less circular opening or through a longitudinal cleft in the vessel-wall. This variety is known as a *sacculated aneurysm* (Fig. 930, 3). If the sac of such an aneurysm

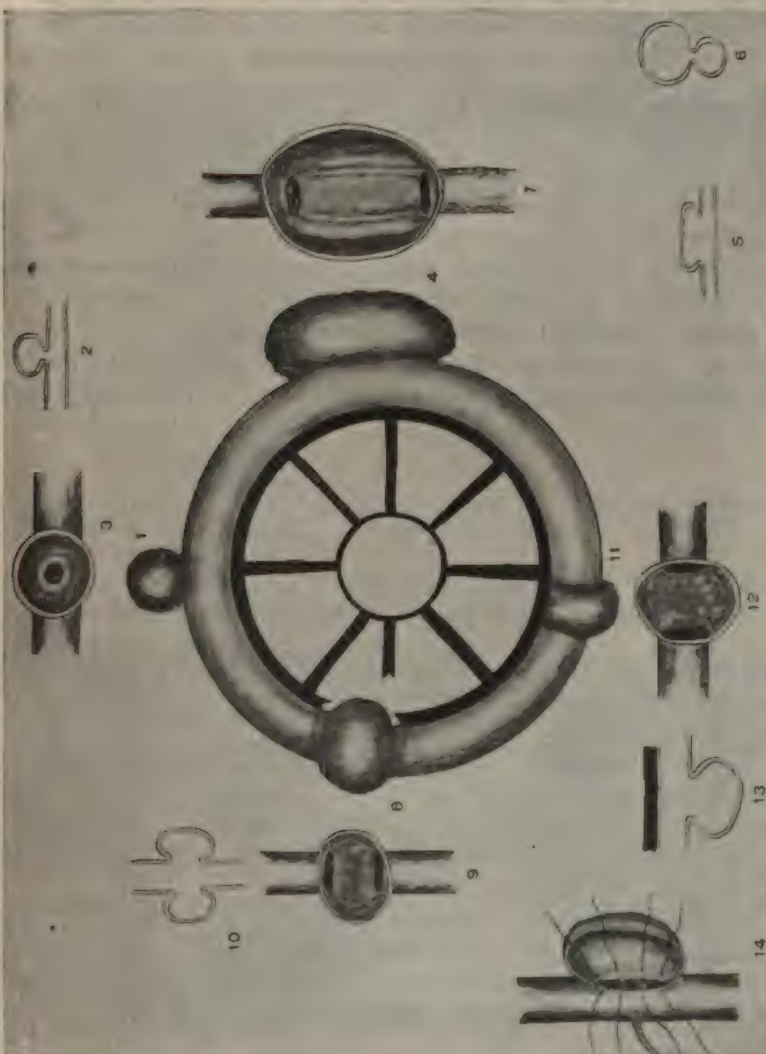


FIG. 930.—Varieties of aneurysm.

is opened, only one orifice may be seen leading into the artery; if two orifices are visible, they are connected by a groove in the wall of the sac leading from one orifice to the other (Fig. 930, 7). This groove consists of normal artery wall, and in fact is the artery which communicates with the sac through a split of limited width instead of through an opening of limited length and width (Fig.

930, 14). A recognition of these facts is very important, as such aneurysms may be suitable for reconstructive operations, while fusiform aneurysms with which they are often confounded are entirely unsuited to such treatment.

(E) A true aneurysm may rupture and form a false aneurysm in addition. This must be remembered as the condition may puzzle an operator when performing endo-aneurysmorrhaphy.

LIGATION

(*a*) **Operation of Antyllus.**—Expose the aneurysm along with the artery immediately above and below it (Fig. 931). Ligate the artery immediately above and below the aneurysm. Open the sac; turn out contained blood-clots; excise as much of the sac as convenient; close the wound. This operation is rarely performed except in very superficial vessels. Other and better methods are available, but the procedure is worthy of note as being the earliest form of operation and being very closely allied to some of the most modern.

(*b*) **Anel's Operation.**—Expose the artery proximal to the aneurysm. Ligate close to the aneurysm, so close, in fact, that no branch is given off from the artery between the ligature and the sac. The objections to this operation

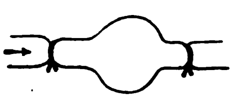


FIG. 931.—Antyllus' operation.

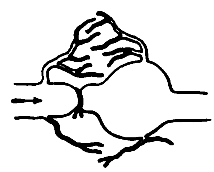


FIG. 932.—Anel's operation.

are that the ligature is applied on more or less diseased tissue (not a very grave fault in view of the success of Matas' operation) and that blood may soon enter the sac through collateral circulation (Fig. 932).

(*c*) **Hunter's Operation.**—To avoid ligating diseased tissue John Hunter operated at a distance from the aneurysm. In popliteal aneurysm he ligated the femoral in Hunter's canal; later surgeons preferred to ligate at the apex of Scarpa's triangle. Collateral circulation does not pour blood into the sac so early as after Anel's operation (Fig. 933).

(*d*) **Brasdor's Operation.**—When an aneurysm is so near the trunk that proximal ligation is impracticable, distal ligation may form a barrier to the onflow of blood, collateral circulation may be established, and a cure result.

Brasdor's operation consists in ligating the main artery distal to the aneurysm (Fig. 934).

(*e*) **Wardrop's Operation.**—When, for example, in innominate aneurysm, the artery divides into two great vessels, the circulation may be sufficiently checked by the ligation of one of these vessels distal to the disease (Fig. 935). This is Wardrop's operation. If ligation of the one vessel prove insufficient, the other branch may be tied as well so that the same condition prevails as in Brasdor's operation.

(f) **Syme's Operation** is practically obsolete. It consisted in incising the aneurysm freely, quickly inserting the finger so as to plug the afferent vessel and then in catching with a forceps, through the cavity of the sac, the mouth of the vessel, and subsequently obliterating it with a ligature or stitch.

(g) **Dix's Operation.**—("Brit. Med. Jour.," Oct. 30, 1875, and "Bryant's Surg.," 3d ed., i, 449.) Gradual constriction of the afferent artery. This method has been much neglected, and yet it has many valuable features. It imitates nature's cure by gradually decreasing and then stopping the onflow of blood. If coldness of the limb indicates that the circulation has been interfered with too much, the constriction may be loosened slightly and an opportunity given for a sufficient establishment of collateral circulation. Stratton, Halstead and Matas have used this same principle in various ways.

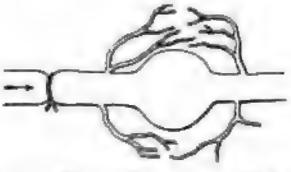


FIG. 933.—Hunter's operation.

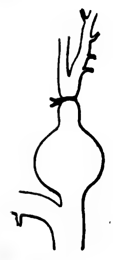


FIG. 934.—Brasdor's operation.

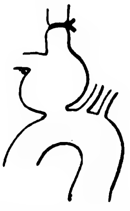


FIG. 935.—Wardrop's operation.

Expose the artery, encircle it with a strand of soft silver wire about nine inches long. With a needle pass the ends of the wire, from within outwards, through the tissues to the surface so as to emerge on the skin, one about a quarter of an inch and the other three-quarters of an inch from the edge of the wound, *both being on the same side of the wound*. Divide a small cork longitudinally; place one-half of this between the emerging ends of wire, flat surface to skin, with its long axis exactly in the line of the artery and press down upon it; twist the ends of the wire over the cork until pulsation ceases in the aneurysm. Close the skin wound. "When depression of anesthesia goes off and the circulation revives, it will be found that a feeble pulsation returns in the aneurysm. This, according to the author (who strongly advocates the *gradual* rather than the *rapid* method of producing coagulation in the sac), should be allowed to go on for two or even three days, when the wire is to be tightened" (Thomas Bryant.) To tighten the wire, press down on the cork and slip small wedges of wood (matches would do) between the wire and the cork. Do not twist the wire afresh lest it break. "About the fifth or sixth day the cure is complete" and the wire may be removed.

EXCISION OF ANEURYSM

Adolf Treutlein ("Munch. med. Woch.," June 19, 1906) recommends that in traumatic aneurysm finger pressure be used to the affected part two or three

times daily for fifteen minutes during a period of about two weeks prior to operation. The object of this preliminary treatment is to encourage the development of collateral circulation and lessen the dangers of gangrene. Ellsworth Eliot, Jr., has preached this doctrine for years. Freely expose the aneurysm by incision. Ligate the artery proximal to the sac. If practicable ligate the artery distal to the sac. Remember that branches may be given off from the sac and that these may bleed. Excise the sac as if it were a *non*-malignant tumor. It may be easy to remove the aneurysm without opening it, it will generally be much easier if the sac is opened and its contents evacuated not merely because of increased ease in manipulation, but because the openings of the branch vessels may be visible and thus their exposure and ligation be facilitated. In old aneurysms with their numerous irregularities and adhesions extirpation may be very difficult. When the wall of the sac is closely adherent to important structures rather leave a portion of the sac *in situ* than jeopardize such.

If temporary hemostasis has been obtained by an elastic constrictor, hemorrhage is likely to be so considerable on its removal that Hildebrand gives the following advice: Tampon the wound and elevate the limb before removing the constrictor. Remove the constrictor. After about 10 to 15 minutes the temporary hyperemia always noticeable after removal of a constrictor will have disappeared, and it becomes easy to pick up and tie all bleeding points.

The development of arteriorrhaphy renders it possible to substitute a more ideal operation for the classical method of excision of an aneurysm. Instead of ligating the artery above and below the aneurysm, it is temporarily occluded by means of Crile's clamps or the like (unless Esmarch's elastic constrictor has been used); the aneurysm is excised and the afferent and efferent segments of the artery are united by suture.

Enderlen (Würzburg) ("Deutsche med. Woch.," 1908, No. 37), excised a popliteal aneurysm. The vein was twice wounded during the dissection and both wounds were sutured. The aneurysm was isolated—all collateral branches were ligated and the sac excised. Flexion of the knee permitted approximation of the divided ends of the artery which were united by Carrel's suture. During after-treatment the knee was kept flexed. After union was assured the knee was gradually extended. At the end of six months the patient resumed work. If it be impossible to approximate the divided ends of the artery the gap may be filled by implanting a segment of vein (*e.g.*, long saphenous). This method was successfully adopted by E. Lexer after he had excised an aneurysm of the axillary artery. Einar Key (Zentralblatt für Chir., Oct. 14, 1911) in extirpating a popliteal aneurysm, excised fully 4 cm. of the artery. The knee was flexed to 45°, and arteriorraphy performed. After 4 weeks the knee could be extended.

OBLITERATIVE ENDO-ANEURYSMORRHAPHY (MATAS)

In situations where temporary hemostasis can be surely secured by the elastic constrictor or some form of compressor, or where all the main vessels entering or leaving the aneurysmal sac can be secured either temporarily by clamps such as Crile's or permanently by ligatures, Matas's operation is easy and efficient.

Step 1.—After assuring temporary hemostasis, make a free incision parallel to the long axis of the aneurysm down to the sac. Do not injure any important structures.

Step 2.—Freely incise the sac so that every part of it is accessible to sight and touch. Remove the contents of the sac and retract its walls so that all the orifices which open into it are visible. Note if there are two main orifices unconnected by a groove of more or less normal arterial wall. If this is the case the aneurysm is fusiform and suitable for the obliterative operation. If the two openings are connected by a groove of more or less healthy arterial wall, note if this groove is wide and contains enough and sufficiently good tissue to permit reconstruction of the artery. If the groove is narrow and composed of

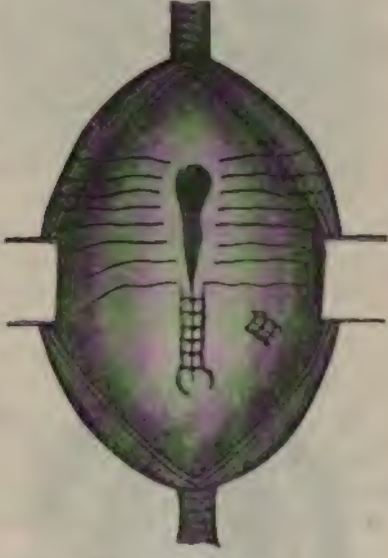


FIG. 936.—(*Matas.*)

suspicious tissue, the aneurysm is either fusiform or practically fusiform and the obliterative operation is imperative. If the groove is wide and satisfactory in character, the aneurysm is sacculated and may be suited to a reconstructive operation. If only one opening is present in the sac wall, the aneurysm is sacculated and a reconstructive operation is usually indicated. On opening the sac one may find it to be a false aneurysm; if this is the case, find the opening into the artery and close it by suture or ligate the vessel, unless the false aneurysm is secondary to the rupture of a true one, when one must treat the true aneurysm after clearing out its contents. The sac of a false aneurysm should be treated in the same fashion as that of a true one.

Step 3.—The aneurysm is "fusiform" (Fig. 936). With sutures of catgut on a curved needle (without cutting edges) close all the orifices entering the sac. With a similar suture (continuous), inserted in the Lembert fashion, obliterate

the deeper portions of the sac, so that all the stitches closing the orifices are hidden (Fig. 937). Turn the flaps of skin plus sac wall inwards and fix them by sutures as in Figs. 938 and 939. Remove the elastic constrictor. Apply dressings. It is of prime importance not to separate the sac from its surroundings, as its walls are poorly nourished at best, and sloughing is to be avoided. Instead of inverting the skin and part of the sac, the author has excised some of the excess of sac wall and obliterated the rest of the cavity of the sac by means of several rows of continuous Lembert-like sutures of catgut and closing the superficial wound by a separate line of stitches.

FIG. 937.—(*Matas.*)

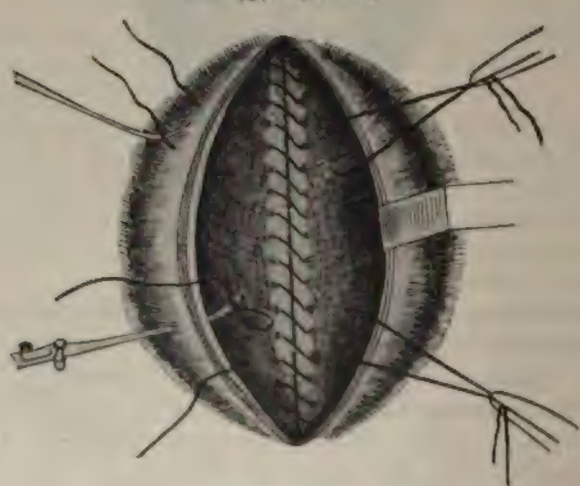


FIG. 938.—(*Matas.*)

cases the walls of the aneurysm are so thick and stiff that it is im-
bring them together with sutures. In these cases C. H. Mayo has
follows: Occlude all the vessels entering or leaving the sac by sur-
.ch with a purse-string suture of catgut. Very moderate tension on
:s suffices. Next place a layer of iodoform gauze over the bottom of
l fix it in place by a continuous suture of catgut. In the same
layer upon layer of the gauze in place, bringing the end of each piece
ıt of the wound. Close the skin wound
re the gauze protrudes. Leave the gauze
l the catgut is absorbed. The cavity soon
factorily.

case of obliterative aneurysmorrhaphy
of Surg.," July, 1908, p. 12) for gluteal
s very instructive. "A young Russian of
years had been developing for three
ıt sciatic neuralgia with disability in walk-
ıe swelling of his foot. A pulsating tumor
gluteal region prevented his lying on that
The man had never had syphilis, but
ed gonorrhœa. His heart showed a blow-
murmur. Examination showed a spher-
ing tumor, three inches in diameter, be-
gluteus muscle at the sciatic notch, where
had caught the sciatic nerve, and held it
.nst the bone—hence the neuralgia.

a particularly good case for operation by
method, because ligation of the internal
.t would temporarily arrest the current, would allow free anastomosis
le return; meanwhile leaving the distended sac to continue sciatic

FIG. 939.—(*Matas.*)

ıy 21, 1906, I opened the iliac fossa and threw a temporary silk liga-
.he internal iliac artery, which was held as a loop by my assistant, Dr.
y, who drew it up against his index finger-tip, so as to avoid crushing
ligation. This compression at once stopped pulsation in the tumor.
sed over the tumor, and separated the gluteus. The sac was well
ınd easily isolated. Its neck filled the uppermost corner of the
h. On compression, after the pulsation had been stopped from above,
and quickly filled again. By inference, this must have been by
s, as the iliac artery was quite occluded by the silk loop.

; no way to keep it entirely empty; I ventured to cut it freely open,
ın instant internal pressure to stop loss of blood. I first plugged the
the gluteal artery with my index finger-tip, and found no other
curred. I was then able to dry its walls and see that they were firm,
erous lining. On releasing my finger pressure ever so little, a sharp
d followed, but not in pulsating current. I now began a continuous

suture of the internal wall, with fine chromicized catgut, first fixing it by a knot just above my finger-tip. The next stitches were placed so as to catch in the sac wall, on both sides of my finger-tip, which I drew back as I quickly tightened them, thus sealing up the deepest part of the funnel-shaped cavity. After placing the first four deep stitches there was no bleeding, and I leisurely secured one wall against the other by continuous back and forth suturing, with the same thread. I even continued this until I had obliterated the entire sac, and closed the superstructures, with no additional knot. The silk thread was removed from the iliac. The wound was bloodless. The patient made an immediate recovery. The patient had no recurrence of tumor or sciatic pain up to three months after operation."

RECONSTRUCTIVE ENDO-ANEURYSMORRHAPHY (MATAS)

Steps 1 and 2 are the same as in the preceding operation.

(*a*) The aneurysm is sacciform. Only one well-defined opening is visible entering the sac. Close the opening by a line of sutures introduced in the Lembert fashion. These sutures should be of No. 1 silk impregnated with sterile

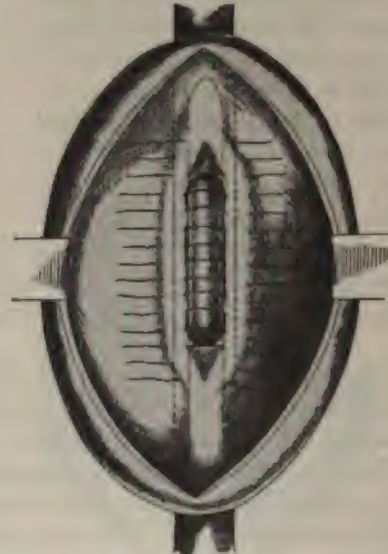


FIG. 940.—(*Matas.*)

vaseline and should be introduced by means of the finest possible intestinal needles. (Curved needles will be most convenient.) Before suturing, the parts to be sutured should be douched with salt solution or coated with vaseline (see Arteriorrhaphy). Obliterate the sac as in the obliterative operation.

Matas originally closed the communication between the artery and the sac with catgut, but the method described above is better.

The author operated (using catgut throughout) in one case, and while the

aneurysm was cured he feels sure that the reconstruction of the artery must have failed as the catgut stitches are well calculated to cause obliteration of the vessel. Even if the artery ultimately becomes obliterated, it probably closes somewhat slowly and gives time for collateral circulation to become established.

(*b*) The aneurysm is sacciform, but there are apparently two openings into the sac connected by a sufficiently wide groove of healthy arterial wall. After douching the groove and the openings with salt solution and smearing them with vaseline (see Arteriorrhaphy), pass the ends of a piece of a soft rubber catheter into the two arterial openings and let the tube lie in the groove (Figs. 940 and 941). Have a loop of thread round the catheter with which to extract it when it has served its purpose. With very fine silk sutures (vaselined) on fine round

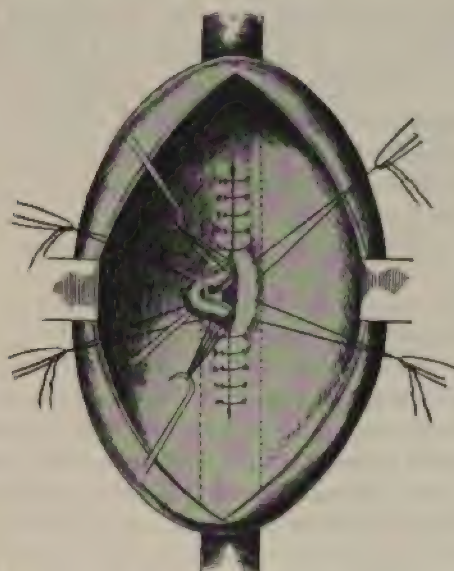


FIG. 941.—(*Matas.*)

needles stitch the sac on one edge of the groove (using healthy tissue) to the corresponding edge on the other side of the groove, over the catheter. Extract the catheter and tighten the sutures. If an extra stitch seems indicated, insert such. Slowly remove the elastic constrictor (or temporary hemostatic agent). If any bleeding takes place at the line of suture, stop it by one or more extra sutures. Obliterate the rest of the sac as in the obliterative operation.

W. J. Frick and the author have each performed this operation using catgut as recommended originally by Matas instead of vaselined silk, in both cases the aneurysm was cured, but as the ankle pulse was not to be felt either before or after the operation there is no proof as to the success of the reconstruction of the artery. Personally, the author thinks that obliteration of the vessel probably occurred due to the kind of catgut used.

When applicable, the author believes one or other of the methods of Matas superior to all others in the treatment of aneurysm.

Macewen's Operation.—In cases of otherwise inoperable aneurysm Macewen has endeavored (successfully in some cases) to assist nature in forming a "white blood-clot" on the walls of the sac. The operation consists in pushing long, delicate, finely polished steel pins, like ladies' hat pins, into the sac and through its cavity so as to touch but not penetrate the inner surface of the sac on the opposite side. The current of blood acting on the pins, makes them quiver and continuously scratch the intima. On the scratched intima a firm white blood-clot is deposited which may become organized and result in a cure. Macewen recommends that the scarification be carried out for about ten minutes at one spot and then that the pin be partly withdrawn and applied at another point. In large aneurysms several pins may be inserted at the same time. "The action of this procedure is slow; sometimes it may be weeks before any noticeable thickening of the coats is made out; sometimes, on the other hand, it may be much more rapid. The pins may be introduced on several occasions; it is well to leave an interval of a week to a fortnight between each introduction" (Cheyne and Burghard).

ARTERIO-VENOUS ANEURYSM

The classical and self-evident method of operating on an arterio-venous aneurysm, whether aneurysmal varix or varicose aneurysm is by ligation of the afferent and efferent vessels with or without excision of the sac. This does well in aneurysm of some unimportant vessels, but when important vessels are involved the ligation of the vein is most dangerous and gangrene is very liable to supervene. The utmost conservatism is in order and the lessons taught in the laboratory must be fully utilized. When it is only possible to save one of the vessels forming an arterio-venous aneurysm, preservation of the vein is of more importance than of the artery; an exception to this rule is found in the case of the carotid and the internal jugular.

Methods of Operating on Arterio-venous Aneurysm Other than by Simple Ligation.—If possible use provisional hemostasis by means of an elastic constrictor; if this is not possible expose the afferent and efferent vessels at an early stage of the operation and control them as in arteriorrhaphy. Incise the sac if one is present or separate the adherent artery and vein one from the other. If the wounds in the artery and vein can be closed without too much narrowing of their lumen, do so in the Carrel fashion. Remove the clamps or constrictors and close the wound.

If the artery is completely divided or nearly so, make an end-to-end arterial anastomosis either by Murphy's invagination method (the pioneer operation) or by Carrel's method. In one case of popliteal arterio-venous aneurysm E. Lexer excised the injured portions of the artery and vein, and although there was 5 cm. (2 inches) of separation between the vessel ends when the knee was extended, he was able to unite artery to artery and vein to vein with Payr's

prosthesis, when the knee was flexed. After six weeks extension of the knee was possible.

Stich ("Deutsche Zeitsch. für Chir.," xcv, 577) extirpated an arterio-venous popliteal aneurysm and united the divided artery by Carrel's circular suture. The operation was performed as follows: Four-inch incision on inner side of thigh immediately above the knee-joint. Exposure and isolation of the aneurysmal tumor which was a sacciform dilatation of the popliteal artery. The vein was torn during an attempt to separate it; as a result it was necessary to resect 1½ inches of the vein at the level of the aneurysm. The artery communicated with both the vein and the aneurysm sac. Suture of both openings in the artery would have produced too much stenosis, so Stich resected a short segment of the artery and united its divided ends by Carrel's method. Slight flexion of the knee permitted easy approximation of the ends of the artery. During the after-treatment the knee was kept slightly flexed. Three months after operation the patient was found to be well.

When, after separation of the unnatural anastomosis between artery and vein, so much tissue is lost that direct end-to-end anastomosis is impossible, a segment of another and unimportant vessel may be implanted. E. Lexer has used a segment of the long saphenous vein to replace a segment of the axillary artery.

CHAPTER LXIII

LIGATION OF ARTERIES IN CONTINUITY

In the succeeding pages the ligation of but a few of the principal arteries is described. These are the vessels which occasionally call for ligation in actual practice. At the present day operations for the tying of other vessels are almost exclusively valuable as anatomic exercise and hence have no place in this work.

A few general remarks on methods of ligating arteries:

1. Refresh the memory regarding the anatomic details of the region to be invaded.

2. Place the limb in good position and mark on it the line of the artery. A line of scratches or very shallow incisions is the best mark to make.

3. Steady the skin with the left hand. This is important, as in making the incision the skin will slide on the deep structures, and the "marked line" will no longer correspond to the artery. Make a clean incision through the skin and superficial fascia. The incision usually must be 2½ to 3 inches long.

Precision in work is required, hence very short incisions are objectionable. Free access is absolutely requisite.

4. Retract or doubly ligate and divide all vessels which come in the way. Pick up thin layers of the deep structures in forceps on each side of the line of incision and thus elevate a *transverse* fold of the tissue which becomes emphysematous and can be safely cut. Continue this proceeding, dividing the tissues layer by layer until the artery in its sheath is reached. When penetrating the deep parts through intermuscular septa the dissection may be accomplished with the handle of the scalpel.

As the wound is deepened its edges must be held apart by blunt retractors; but the retraction must be made with care, otherwise the depth of the wound will be distorted and the line of the artery lost. The deep structures must be divided as extensively as the skin or nearly so.

5. The artery being reached must be distinguished from neighboring veins and nerves. The nerves appear as white, firm, solid cords. The veins when empty look like thin fibrous sheets, when full they are soft, easily compressed, and when compressed they fill up on the distal side. The veins are larger than and often overlap the arteries, and through them the pulsation of the artery may be felt. Occasionally nerves may transmit pulsation in a most deceiving manner from the artery to the palpating finger. Arteries feel to the finger like fairly firm tubes, and they pulsate. This pulsation may, however, be feeble under certain circumstances or, as already noted, it may be transmitted to nerves, etc., and thus error may arise. During every step of the operation from skin incision to exposure of the vessel be careful to recognize every anatomic guide

either by eyesight or by touch. Farabeuf, speaking of the importance of touch, says the surgeon should, in the dissecting-room, "accustom himself to ligate certain arteries with his eyes in the air and his fingers in the wound as soon as the superficial incision has been made." Accurate hemostasis and a dry wound are of much importance.

6. The artery lies in a fibrous sheath much as a tendon does. This sheath must be opened. When the fibrous sheath has been exposed, with dissecting

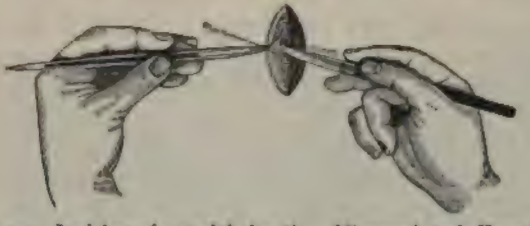


FIG. 942.—Incision of arterial sheath. (*Esmarch and Kowalzig.*)

forceps pick up a transverse fold of it (Fig. 942). If the forceps are applied from side to side so as to pick up a longitudinal fold of the sheath they may include in their bite a portion of the wall of the vessel.

Apply a scapel with its flat surface to the vessel and cut a notch in the elevated fold of sheath, parallel to the vessel. Lay aside the knife. Do not let loose the forceps. With the blunt point of a probe, director, or aneurysm needle insinuated through the opening in the sheath separate the sheath from the vessel for a short distance and catch the edges of the wound in the sheath with fine-pointed hemostasis forceps; unless this is done it may be difficult to find the opening in the sheath again. Pass the aneurysm needle between the sheath and the artery half way round the vessel in one direction, and then do the same in the opposite direction. In this manner about $\frac{1}{4}$ inch of the artery is completely separated from its sheath. From the vein side of the artery pass the aneurysm needle completely round the vessel under the sheath. When the eye of the instrument protrudes at the opposite side of the vessel, thread it; withdraw the needle and thus place the ligature in position. If the needle is armed with a stout ligature before being passed the thread greatly impedes the manœuvre. On the other hand, it is often difficult to thread the needle after it has been passed. To avoid these difficulties the author arms the needle with a fine thread of silk or hemp, passes the needle thus armed round the vessel, picks up the loop of the fine thread, withdraws the needle, passes a stout ligature through the loop, withdraws the loop, and so brings the ligature into position (Fig. 943). If too much of the artery is separated from its sheath nutrition is impaired and the vessel may necrose.

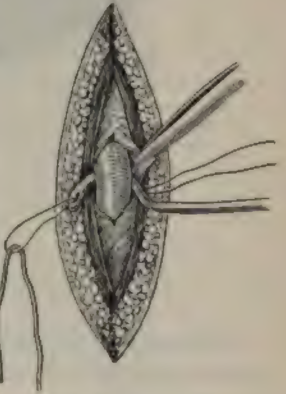


FIG. 943.

7. The ligature may be of catgut, silk, hemp, tendon, ox-aorta, etc., according to the whim of the operator. Tie the ligature in a reef knot. If catgut is used make three ties. Some surgeons recommend that the ligature be tied tightly enough to rupture the intima. This is not necessary, all that is requisite is to have the lumen obliterated and the inner surfaces of the intima in contact.

8. Close the wound accurately. Apply dressings. Keep the limb at rest, elevated and warm.

LIGATION OF THE COMMON CAROTID ARTERY

(A) Ligation at the site of election, *i.e.*, above the omo-hyoid muscle in the carotid triangle.

Place the patient on his back with a firm pillow under the shoulder and neck with his chin directed upwards and towards the opposite side (the head moderately extended and rotated).

Step 1.—**Method A.**—Make a three-inch incision along the anterior margin of the sterno-mastoid having its mid-point opposite the cricoid cartilage. Divide the subcutaneous tissue and the platysma throughout the length of the wound. Do not unnecessarily injure the superficial veins.

FIG. 944.—Exposure of common carotid and lingual arteries. (*Kocher.*)

Method B.—Kocher's Incision.—At the level of the cricoid cartilage make a three-inch horizontal incision through the skin and platysma. The incision follows the direction of the folds in the neck and is slightly oblique from above downwards and inwards (Fig. 944).

The centre of the incision must correspond to the anterior edge of the sterno-mastoid. Divide the fascia covering the sterno-mastoid. Retract the edges of the wound.

Step 2.—Retract the sterno-mastoid outwards. Recognize the anterior belly of the omo-hyoid. Palpate for the carotid tubercle (transverse process, sixth cervical vertebra) at the angle formed by the crossing of the sterno-mastoid and the omo-hyoid. The artery crosses the tubercle. Observe a nerve running

downwards throughout the wound (descendens noni); it lies directly on the sheath of the carotid vessels. Open the common sheath of the carotid vessels to the inner side of the descendens noni nerve, and retract outwards the nerve and the corresponding portion of the sheath (Fig. 945).

Step 3.—Note the internal jugular vein lying to the outer side of, and sometimes overlapping the artery. The vagus nerve lies behind and between the artery and vein. Pass an aneurysm needle round the artery from the outer side inwards. Beware of including the vagus nerve in the ligature.

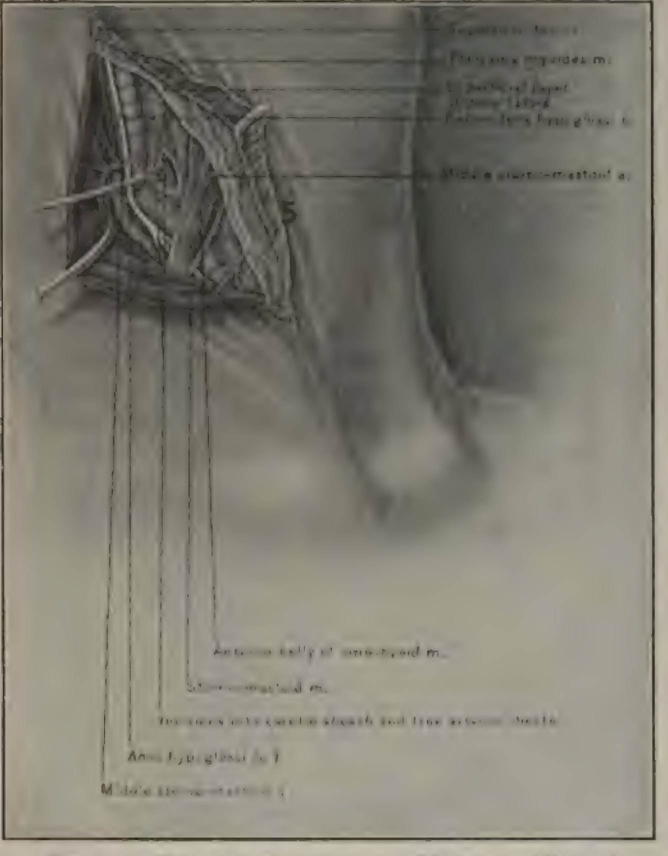


FIG. 945.—Exposure of common carotid artery. (*Deaver.*)

LIGATION BELOW THE OMO-HYOID MUSCLE

(B) Here the artery is deeply seated and is difficult to expose.

Step 1.—**Method A.—Kocher's Incision.**

Method B.—Make a 3-inch incision having its lowest end ¾ inch external to the sterno-clavicular articulation. This incision is parallel to the sterno-mastoid and lies between its sternal and clavicular portions.

Method C.—Make a 3-inch incision along the anterior margin of the sterno-mastoid from the level of the cricoid cartilage downwards.

Step 2.—**Method A.**—Incision (b) has been made. Divide the platysma throughout the length of the wound. Penetrate between the two heads of the sterno-mastoid, until the internal jugular vein is seen. Retract outwards the vein and the clavicular portion of the sterno-mastoid. Retract inwards the

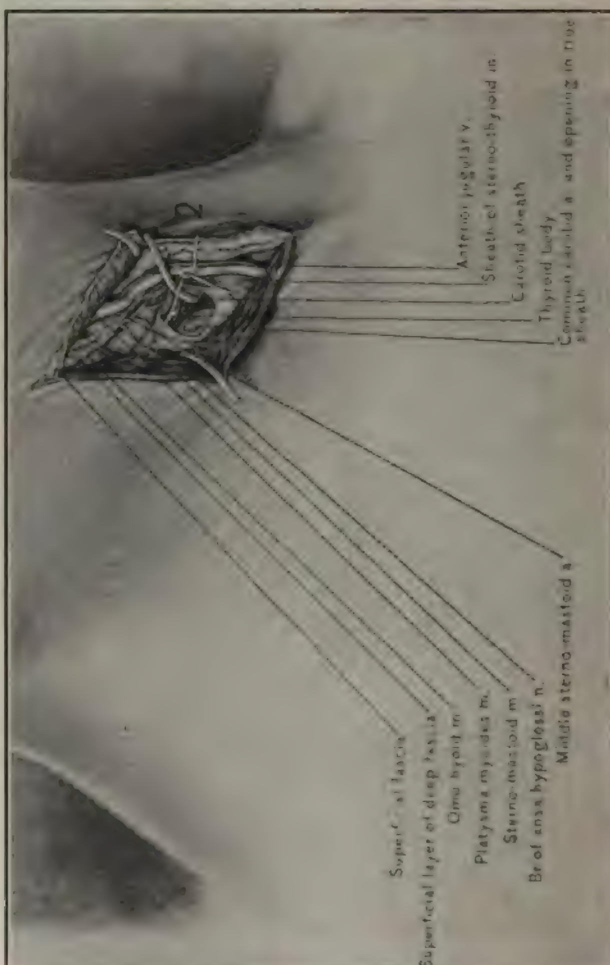


FIG. 946.—Exposure of common carotid below omo-hyoid. (*Deaver.*)

sternal portion of the sterno-mastoid and with it the sterno-hyoid and sterno-thyroid muscles. The vagus lies to the inner side of the vein, the carotid artery lies somewhat more internal and deeper, under the vein (Fig. 946).

Method B.—Incision (a) or (c) has been made. Divide the deep fascia along the anterior edge of the sterno-mastoid. Expose the sterno-hyoid and sterno-thyroid muscles. Retract the latter muscles inwards and the former outwards. This exposes the carotid sheath. The descendens noni nerve is

not seen on the front of the sheath in this region (Da Costa). Feel the carotid tubercle in the upper part of the wound. As the artery crosses the tubercle it is a valuable landmark.

During the exposure of the carotid sheath a number of veins may require ligation and division.

Step 3.—Open the sheath on its inner side, clear the vessel, and pass the aneurysm needle around it from without inwards, carefully avoiding the vagus nerve.

Remarks.—Ligation of the common carotid may be indicated in cases of wounds, aneurysm, malignant neoplasms (in order to starve the growths), and in hydrocephalus.

Cerebral disturbances frequently follow ligation of the common carotid. These accidents have become less frequent. LeFort's statistics show 45 per cent.; Siegrist's 38 per cent.; Jordan accepts 25 per cent. as being correct; De Fourmestraux (French Congress of Surg., 1908) has experienced the accident in 21 per cent. of his personal cases, while in such operations as for exophthalmos that surgeon's death rate fell to 5 or 6 per cent. De Fourmestraux thinks the cerebral disturbances result from ascending thrombosis due to some trifling infection at the point of ligation.

Such being the case, the surgeon is always in doubt whether the patient will come out of the anesthesia, and if he does whether he will exhibit hemiplegia or progressive cerebral softening. In view of these difficulties Jordan recommends partial constriction of the artery for about forty-eight hours before definite ligation. From experiments Jordan finds that it is possible to apply a tape or coarse catgut ligature around the vessel sufficiently firmly to stop the peripheral pulse but sufficiently gently not to injure the intima. This constriction can be kept up for two days without coagulation taking place, and when the constrictor is removed the circulation soon becomes normal again. The preliminary tentative ligation must be accomplished under local anesthesia to permit of immediate observation of any cerebral symptoms which may develop. If the constrictor causes disturbance it may be lessened or removed. By gradual increase of constriction it may be possible to increase collateral circulation. If no objectionable symptoms develop, the ligation may be made complete and permanent.

Matas attains the same ends by bending a narrow strip of metal around the vessel with pressure sufficient to stop the blood current but insufficient to injure the vessel wall. This metal strip is buried; if no symptoms develop it is left *in situ;* if symptoms develop the wound is reopened and the metal removed.

Hydrocephalic children bear ligation of the common carotid well. In these cases both arteries must be tied, but ten days must elapse between the operations (Ballance).

Ransohoff ("Surg., Gyn., Obstet.," August, 1906) advocates ligation of the common carotid, external carotid, and superior thyroid arteries in cases of pulsating exophthalmos.

Instead of permanently occluding the common carotid, temporary occlusion

may be employed to prevent hemorrhage during various operations. For this purpose Fowler threw a tape around the vessel, securing the tape by forceps, while Crile successfully uses his special forceps.

LIGATION OF INTERNAL JUGULAR VEIN

Ligation of the vein may be necessary in cases of sigmoid sinus thrombosis. The operation is practically the same as for ligation of the carotid. Particular care must be exercised in passing the ligature around the vein, as its walls are very thin and its size varies greatly during expiration and inspiration.

LIGATION OF THE EXTERNAL CAROTID ARTERY

Position of patient as in ligation of the common carotid.

Method A.—*Step* 1.—Make an incision about 2½ to 3 inches in length along the anterior margin of the sterno-mastoid. The centre of the incision must be opposite the greater horn of the hyoid bone. Divide the platysma and

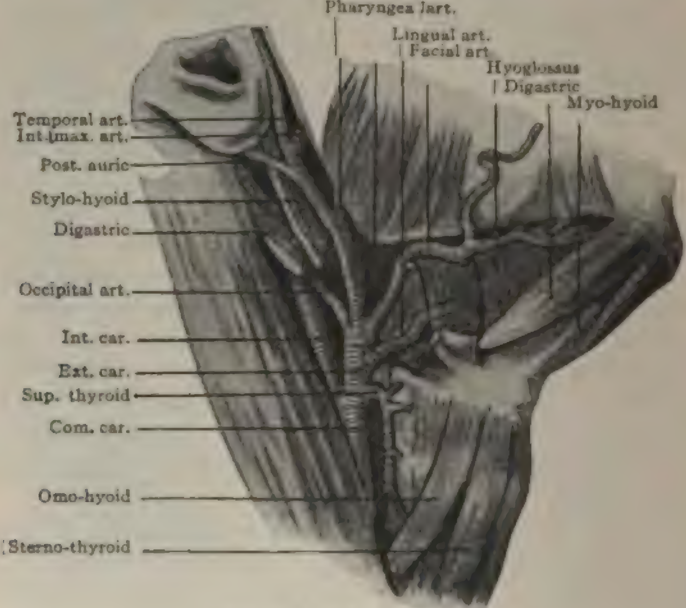


FIG. 947.—(*Esmarch.*)

the deep fascia (attached to the sterno-mastoid) throughout the length of the wound. Retract the sterno-mastoid outwards.

Step 2.—Find the posterior belly of the digastric muscle in the upper part of the wound (Fig. 947). Find the hypoglossal nerve a little below the digastric (Fig. 948). Retract these structures upwards. Avoid injuring the facial and superior thyroid veins.

Note the tip of the great cornu of the hyoid bone and expose the artery opposite this guide. As the internal carotid has been mistaken for the external, it is very wise to demonstrate one of the branches of the external carotid before passing a ligature around the vessel.

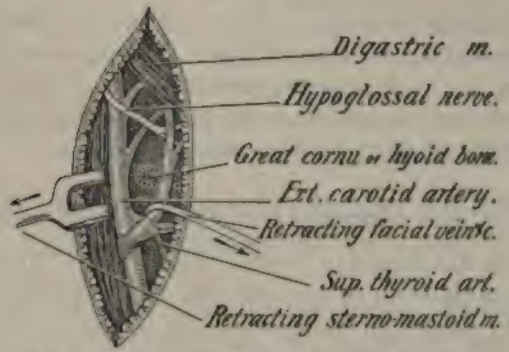


FIG. 948.—Exposure of right external carotid.

Step 3.—Pass a ligature around the vessel from without inwards, avoiding the vein which lies to the outer side of, and frequently overlaps the vessel, and also avoiding the superior laryngeal nerve which runs behind it.

Method B.—Kocher's Incision.—*Step* 1.—Choose a point on the anterior margin of the sterno-mastoid muscle, one finger's breadth below the angle of the

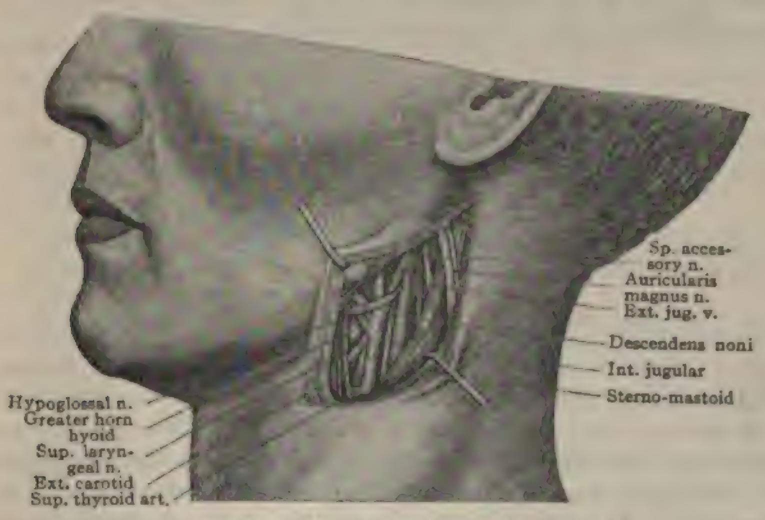


FIG. 949.—Exposure of external carotid. (*Kocher.*)

jaw. Make a slightly oblique horizontal incision having its centre at the above point (Fig. 949). After exposing the anterior edge of the sterno-mastoid the operation becomes practically the same as Method A.

Indications.—(*a*) Hemorrhage from wounds of branches.

(*b*) As a preliminary step in the removal of some tumors, *e.g.*, of the retropharyngeal space.

(*c*) Aneurysm.

(*d*) Occasionally to prevent hemorrhage from the middle meningeal artery during operations on the Gasserian ganglion.

Remarks.—Hearn ligates the external carotid as a preliminary to excision of the superior maxilla for malignant disease, and states that in doing so he exposes some enlarged lymph nodes which would otherwise escape notice. Matas thinks it important to place the ligature well above the bifurcation of the common carotid to avoid the danger of cerebral embolism.

LIGATION OF THE INTERNAL CAROTID ARTERY

Step 1.—Expose the external carotid (see p. 842). The internal, at its origin, lies a little behind and to the outer side of the external carotid.

Step 2.—Gently retract the external carotid inwards. Open the sheath of the internal carotid immediately over the artery. Remember that the artery, the internal jugular vein and the vagus occupy the same sheath, the vein being external and the nerve behind and between the vessels. Pass the aneurysm needle around the artery from without inwards.

Indications.—For intra-cranial aneurysm of vessels other than the meningeal. For hemorrhage, *e.g.*, after tonsillectomy. If the operation seems called for because of hemorrhage after tonsillectomy, expose and apply pressure to the external carotid—if this controls the bleeding it must be from the tonsillar artery and ligation of the internal carotid becomes unjustifiable.

FIG. 950.—Ligation of left lingual artery. (*Esmarch and Kowalzig.*)
d, Digastric. *Oh*, Great horn hyoid. *hg*, Hyoglossus. *gl*, Salivary gland. *st*, Stylohyoid.

Lingual Artery.—The lingual artery arises from the external carotid at the level of the great horn of the hyoid bone (Fig. 947). After running a curved course it dips under the hyoglossus muscle and proceeds forwards parallel and close to the greater horn of the hyoid. It is crossed by the digastric and stylohyoid muscles. The hypoglossal nerve runs parallel to the lingual artery, but is more superficial, being separated from it by the hyoglossus muscle.

The Operation.—*Step* 1.—**Method A.**—Make an incision parallel to and about 1½ inches above the great horn of the hyoid. Divide the skin and the platysma. Divide the deep fascia. Ligate and divide or retract any veins which come in the way.

Step 2.—Retract the submaxillary gland upwards (Fig. 950). Expose the posterior belly of the digastric under which lies the hypoglossal nerve. The nerve forms a good guide to the hyoglossus muscle on which it lies. The lingual vein may lie either superficial to the hyoglossus or beneath it along with the artery. Avoid injury to the nerve and vein.

Step 3.—Carefully divide the hyoglossus (on a director) between the hypoglossal nerve and the great horn of the hyoid. This exposes the lingual artery, which is accompanied by a vein or *venæ comites.*

Method B.—Kocher.—*Step* 1.—Make an incision parallel to and immediately above the hyoid bone, from the anterior edge of the sterno-mastoid to the body of the hyoid.

Divide skin, platysma, and fascia, as if to lay bare the great horn of the hyoid. The digastric and stylohyoid muscles and the submaxillary gland appear in the upper part of the wound.

Step 2.—Let the assistant exercise vertical pressure on the great horn of the hyoid on the opposite side of the neck; this pushes the bone into the wound. Seize the horn of the hyoid with a hook and pull it up, so that the whole region becomes superficial. Note the fibres of the hyoglossus muscle running upwards and the hypoglossal nerve passing from behind forwards over the muscle.

Step 3.—With utmost care divide the hyoglossus, transversely, immediately above the bulbous end of the great horn of the hyoid. This exposes the artery.

Indication for ligation of the lingual artery:

(1) Preliminary to excision of the tongue. (2) To starve malignant neoplasms in territory supplied by the artery. (3) To stop hemorrhage.

Superior Thyroid Artery.—Kocher's Method.—Ligation of the superior thyroid artery is done at the top of the upper horn of the thyroid gland.

Step 1.—(A) Make an incision parallel to and immediately above the hyoid bone, from the anterior edge of the sterno-mastoid to the body of the hyoid. Divide the skin, platysma, and fascia. Retract the lower edge of the wound strongly downwards.

(B) If the upper horn of the thyroid gland does not extend far up the neck, make the incision 3/4 inch lower, corresponding to the upper margin of the thyroid cartilage.

Step 2.—Feel the pulsations of the anterior branch of the artery on the median-anterior side of the upper horn of the thyroid gland beside the larynx. Follow this vessel over the apex of the gland until the main artery is reached.

Step 3.—Ligate the main artery.

The only indication for ligation of the superior thyroid artery is hyperthyroidism. C. H. Mayo, Stamm and others prefer to ligate the upper pole of the thyroid gland, thus tying the branches of the superior thyroid artery in a mass ligature.

LIGATION SUPERIOR POLE OF THYROID

If general anesthesia is to be used administer morphine gr. 1/6 with atropine gr. 1/100 about half an hour before operation.

Step 1.—Make a transverse incision, if possible in a natural crease, two and one-half inches in length, crossing the central part of the thyroid cartilage. The cut divides the skin and platysma and gives access to the gland on both sides.

Step 2.—Retract the inner border of the sterno-mastoid outwards and ex-

FIG. 951.—Ligation of superior pole of thyroid. (*Mayo, Annals of Surgery.*)

pose the omo-hyoid. Retract the omo-hyoid upwards and inwards. Under the omo-hyoid lies the upper pole of the thyroid.

Step 3.—Pass a ligature (linen, silk) round the upper pole and tie it (Fig. 951). If a vein is pierced by the aneurysm needle and causes bleeding pull upon the ligature and pass a second ligature including more tissue. The

ligature includes veins, arteries, and gland tissue. There is no danger of injuring the recurrent laryngeal nerve (Mayo, "Annals of Surg.," Dec., 1909).

Stamm and Jacobson strongly recommend ligation of the upper pole in exophthalmic goitre when more radical operations seem inadvisable. The author finds the operation by no means difficult.

Inferior Thyroid Artery.—*Step* 1.—Expose the common carotid artery and internal jugular vein immediately below the tendon of the omo-hyoid. (Do this either through Kocher's incision or through an incision along the inner margin of the sterno-mastoid).

Step 2.—Gently retract outwards the carotid packet of vessels and nerves. Pull the tendon of the omo-hyoid upwards. Push the thyroid gland and the trachea inwards (*i.e.*, towards the opposite side).

Note the transverse process of the sixth cervical vertebra (carotid tubercle). Opposite this fixed point the inferior thyroid artery may be seen appearing from *behind* the common carotid at about the same level as the omo-hyoid tendon crosses in *front* of that vessel.

Step 3.—Ligate the artery as far from the thyroid gland as possible to avoid injury to the recurrent laryngeal nerve which crosses the artery behind the gland. Be careful not to include in the ligation the middle cervical ganglion or the recurrent laryngeal nerve.

The indications for ligation of the inferior thyroid artery (and for the superior as well) are certain forms of goitre.

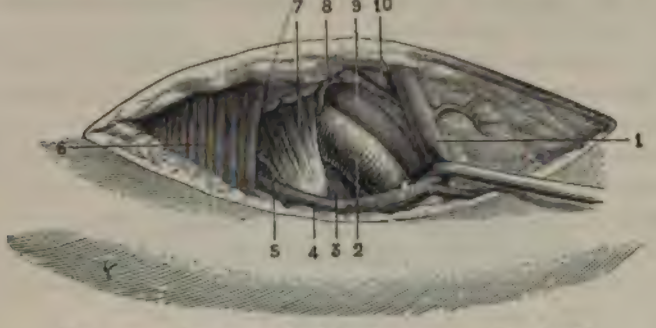


FIG. 952.—Exposure of subclavian artery. (*Farabeuf.*)

1. Ext. jugular vein—retracted outwards. 2. Artery. 3. First rib. 4. Subclav. vein. 5. Supra scap. art. 6. Sterno-mastoid. 7. Scalenus ant. 8. Transverse cervical art. (post. scapular). 9. Brachial plexus. 10. Omo-hyoid.

Subclavian Artery.—Place the patient on his back, support the shoulders on a pillow so that the head may be extended and turned to the opposite side. Keep the arm well pulled downwards (when possible pass the arm behind the back so as to keep it in proper position).

Step 1.—Choose a point one-half inch above and one inch internal to the middle of the clavicle. Let this point be the centre of a three-inch incision parallel to the clavicle and extending from the Trapezius to the sterno-mastoid. In making this incision be careful not to injure the external jugular vein. Divide the skin and the platysma. Retract the external jugular outwards or, if requi-

site, divide it between two ligatures (Fig. 952). At this stage difficulties may be encountered due to the venous plexus formed by the transverse cervical and suprascapular veins. If these veins cannot be retracted out of the way, they must be ligated and divided. A dry wound is essential. Divide the deep fascia throughout the extent of the wound.

Step 2.—Note the outer edge of the scalenus anticus muscle. The subclavian vein lies in front of the muscle, the subclavian artery behind it and at a slightly higher level than the vein. Pass the finger along the edge of the muscle until the scalene tubercle on the first rib is felt. The artery lies immediately outside and behind the tubercle. If the omo-hyoid muscle is in the way, retract it upwards.

Step 3.—The lowest cord of the brachial plexus lies immediately above the artery and has been mistaken for it. Systematically expose this nerve cord sufficiently to permit of precise recognition (Treves).

Pass the aneurysm needle around the artery from above downwards and from behind forwards, guiding the needle with the finger and holding the vein out of harm's way. Pull a ligature around the vessel and tie it.

Step 4.—Close the wound.

Ligation of the third part of the subclavian artery has alone been described here as the other segments of the vessel are unsuitable for and very rarely require ligation.

Indications.—Axillary aneurysm; axillary hemorrhage; wounds; preliminary to excision of the scapula, or of the entire upper limb, etc., and as treatment for innominate and aortic aneurysms.

Riedel ("Zentralblatt für Chir.," 1907, No. 32) objects to the classical method of ligating the subclavian because the work is not sufficiently guided by the eye. He advocates the following method:

1. Make an incision parallel to the direction of the great vessels of the neck from the level of the transverse process of the fifth cervical vertebra to the middle of the clavicle. Divide the skin and platysma.

2. Doubly ligate and divide the numerous veins which appear; also the transversalis coli artery. The superior nerve trunk soon appears emerging from between the scalenus anticus and medius.

3. Work into the groove between the scalenus anticus and medius (distinguished one from another by the emerging nerve trunks). Working downwards, expose the second and third nerve trunks, below the last of which lies the artery. In spite of the depth of the wound, it is *comparatively* easy to sufficiently expose the artery and to ligate it. The whole operation should be performed without introducing the finger into the wound (Riedel) unless gloves are worn.

Axillary Artery.—**Farabeuf's Method.**—Place the patient on his back at the edge of the table with the arm at right angles to the body. Do *not* either flex or extend the forearm fully.

Step 1.—From the apex of the axilla make a three-inch incision down the arm, immediately behind the anterior wall of the axilla, along the inner and posterior border of the coraco-brachialis (Fig. 953). As soon as the skin is

divided, the posterior edge of the wound retracts and discovers the brachial plexus and axillary vein visible through the aponeurosis (Farabeuf). Elevate the pectoralis major and under it, *i.e.*, *anterior* to the vessels and nerves, divide the fascia so as to expose the coraco-brachialis muscle.

Step 2.—Recognize the coraco-brachialis muscle (first guide) and free its inner border for a short distance. Relax the muscle by bringing the arm nearer to the patient's side. Retract the muscle forwards with a blunt hook.

Step 3.—With the finger introduced between the coraco-brachialis and the packet of vessels and nerves, push the latter backwards. Very slowly and lightly remove the finger. As this is done one cord escapes from the pocket and slips forwards (*i.e.*, upwards, the patient lying on his back) (Fig. 954). The cord lies free; it does not perforate the muscle as the musculo-cutaneous nerve does; it is the median nerve (second guide). Isolate the nerve and retract it with the coraco-brachialis. The next cord felt under the finger is the axillary artery, readily recognized by touch and sight. In order to be sure of tying the artery above where the circumflex branches off, isolate the vessel in the upper part of the wound.

FIG. 953.—Exposure of axillary artery. (*Farabeuf.*)

Step 4.—With the finger push the rest of the axillary vessels and nerves backwards (the median nerve is already out of the way). Pass an aneurysm needle around the artery from behind forwards.

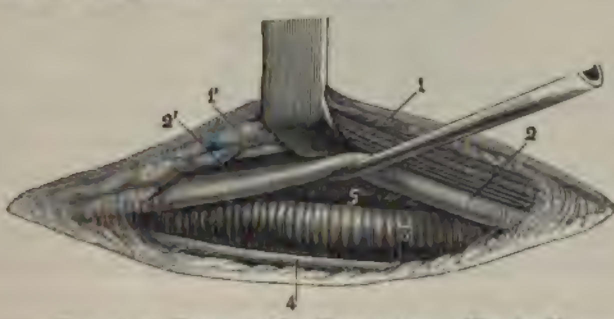


FIG. 954.—Exposure of axillary artery. (*Farabeuf.*)

The retractor supports the 1st landmark, the coraco-bracialis (1) with the musculo-cutaneous n. (1'); the director supports the 2nd landmark, the median n. (2.,2'). 3 = the art. 4 = int. cutaneous n. 5 = deeply seated small collateral veins.

Brachial Artery.—The superficial position of the brachial artery is such that its ligation seems easy, but the reverse is the case. Numerous and rather humiliating errors have been reported by good operators. The artery is subject to abnormalities. (*a*) The artery may lie in front of instead of behind the median nerve (one out of six cases). (*b*) The artery may divide high up and thus during the operation two arteries may be met instead of one, each or both of which may require ligation. (*c*) "The artery may be partially covered by a muscular slip given off from the pectoralis major, biceps, coracobrachialis, or brachialis anticus."

The brachial is rarely tied elsewhere than in the middle of the arm.

Step 1.—With the forefinger hold a thread against the skin of the deepest point (the apex) of the axilla. Hold the other end of the thread (drawn tense) on the mid-point of the fold of the elbow. The course of the thread gives the line of the brachial artery.

Step 2.—Along the line of the artery, make a 2½ inch incision through the skin on the inner border of the biceps. Divide the fascia covering the muscle, *thus exposing the muscle itself.*

Step 3.—Free the inner edge of the muscle and very gently retract it outwards; the forearm being slightly flexed to relax the muscle. This exposes the median nerve.

Step 4.—Mobilize the nerve and retract it outwards or inwards as may be most convenient. This exposes the artery accompanied by its two veins.

Step 5.—Open the arterial sheath. Ligate.

Note.—During the operation the arm must be abducted and supported by the elbow or forearm. The arm itself must *not* be directly supported, as pressure on the triceps would alter anatomic relations, thus making exposure of the artery difficult.

Iliac Arteries.—The iliac arteries, especially the internal vessel, are of so much and varied surgical importance that they deserve full consideration. The usual anatomical works do not cast much light on the subject from the surgeon's standpoint. Quènu and Duval ("Revue de Chirurgie," Nov., 1898) study the anatomy of the iliac arteries in a soul-satisfying and practical manner; the following paragraphs are based on their work.

The common iliac arteries bifurcate at the lower level of the fifth lumbar vertebra, *i.e.*, at the sacro-vertebral angle, 1⅜ inches (3.5 c.) from the middle line (Fig. 955). Near their origin the external and internal iliac arteries lie close together; at the very brim of the true pelvis they are hardly ¼ inch apart. The ureter crosses the external iliac artery slightly outside and above the internal iliac at the point of election for ligation of the latter, *i.e.*, a little below the brim of the pelvis. The ureter is fortunately more adherent to the peritoneum than to the subjacent structures, and hence is easily retracted along with the peritoneum. Such are the relations of the iliac arteries near the bifurcation on the *right* side; on the *left* side the surgical anatomy may be the same or very different, according to the arrangement of the sigmoid or pelvic colon and its meson.

Let us consider the sigmoid as consisting of two parts, one superior (the colonic sigmoid), the other inferior (the rectal sigmoid). The meson belonging to the inferior or rectal sigmoid arises *always* in the middle line of the lumbosacral region. The meson belonging to the superior or colonic sigmoid has no fixed line of origin. Its lower part is always attached along with the meson of the rectal sigmoid, but its upper part may be attached to the parietes anywhere between the spleen (fœtal type) and the pelvic brim (adult type).

The point of junction of the meson of the two portions of sigmoid constitutes the dome of the intersigmoid fossa, and on the floor of this fossa lie the iliac vessels and the spot where the internal iliac must be tied.

The length of the sigmoid varies greatly and with it the length of the meson. If the sigmoid is long, it can be turned upwards with the whole of its meson in such a manner that the intersigmoid fossa becomes obliterated and the iliac bifurcation is as easily exposed as on the right side of the body. If the sigmoid is short its meson is short likewise; by turning the gut upwards its meson becomes

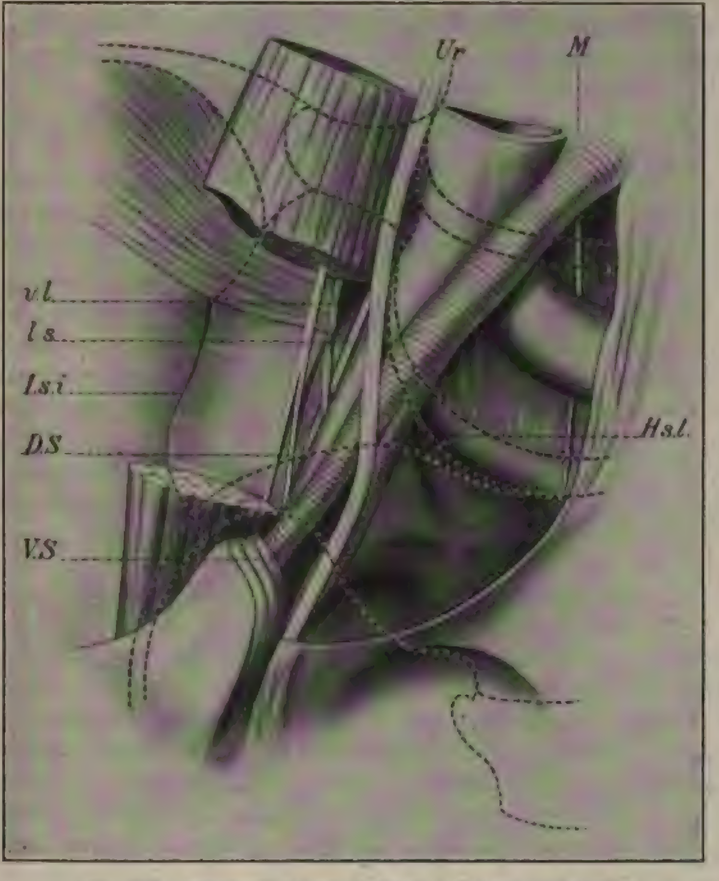


FIG. 955.—Exposure of iliac arteries. (*Quénu and Duval.*)
M, median line; *Hsl*, int. iliac; *Ur*, ureter; *I.s.i.*, sacro-iliac joint; *D.S.*, brim of pelvis.

folded on itself; it is impossible to expose the point of union of the superior and inferior portions of the meson; the intersigmoid fossa is a true fossa or tunnel; it is impossible to reach the bifurcation of the iliac artery without going through the meso-sigmoid. This second arrangement of the sigmoid is the rule.

LIGATION OF THE INTERNAL ILIAC ARTERY

(A) **On the Right Side.**—*Step* 1.—Place the patient in the Trendelenburg position (75°).

Method A.—Open the abdomen by a vertical incision either in the middle

line or through the rectus muscle reaching from the pubis to near the umbilicus. This more or less median incision is the best if the vessels on both sides are to be tied.

Method B.—Make a vertical incision through the skin and anterior layer of the rectus sheath near the outer edge of the rectus. Either split the rectus muscle or pull it towards the middle line. Incise the posterior layer of rectus sheath and the peritoneum along a line corresponding to the skin incision.

Method C.—Open the belly by the gridiron or muscle-splitting method devised by McBurney for appendicectomy.

Especially in fat patients, method A is the best, as very free access to the vessels is of great value.

Step 2.—Widely retract the edges of the abdominal wound. Push the small intestines out of the way and protect them with pads. Put the index finger on the sacro-lumbar promontory in the middle line. Note a point $1\frac{3}{8}$ inches (3.5 c.) to the right side at the same level. At this place a pulsating prominence is visible running from above downwards and outwards. This pulsating prominence consists of the common and external iliac arteries. Another prominence (the ureter) can be seen crossing it. Run the finger down the common iliac artery until the bifurcation is reached when pulsation will be felt on both sides of instead of only under the finger.

Step 3.—Make an incision $1\frac{1}{2}$ inches long through the parietal peritoneum, $1\frac{3}{8}$ inches to the right of the middle line, parallel to the iliac vessels and having its mid-point opposite the lumbo-sacral prominence. Elevate the edges of this wound by blunt dissection. The ureter comes away with the outer edge of the wound and is thus lifted out of harm's way. At the upper angle of the peritoneal wound lies the common iliac, at the centre of the wound lies the bifurcation, at the lower angle lie the external and internal iliacs, side by side, still covered by a sheath of fascia.

Step 4.—Incise the facial sheath *secundum artem;* denude the internal iliac; pass an aneurysm needle from without inwards, closely hugging the artery so as to avoid injury to the external iliac vein, and apply a ligature $\frac{3}{4}$ inch from the origin of the vessel, *i.e.*, at a point a very little below the brim of the true pelvis. Do not forget that the internal iliac vein lies to the inner side of the artery.

(B) **On the Left Side.**—*Step* 1.—Put in Trendelenburg's position. Open the abdomen either in the middle line or on the *left* side.

Step 2.—(*a*) If the sigmoid is long and provided with a long meson, turn it upwards. This obliterates the intersigmoid fossa and leaves the vessels as well exposed as on the right side. Ligate the vessel in the same manner as on the right side.

(*b*) If the sigmoid is short and has a short meson it cannot be turned up so as to expose the vessels. Pull the sigmoid downwards so as to spread out its meson. Note the position of the mesenteric vessels in the meson; they must not be injured. At a point $1\frac{3}{4}$ inches from the middle line on a level with the lumbo-sacral prominence make a vertical incision through the meso-sigmoid, carefully avoiding injury to any of its vessels (Fig. 956). The middle of this

incision corresponds to the lumbo-sacral prominence and its lower end must *not* approach the sigmoid closer than $1\frac{1}{4}$ inches, lest some of the arterial loops be damaged. If the meson is thick and much infiltrated with fat, it must be penetrated slowly by blunt dissection to avoid injuring the vessels.

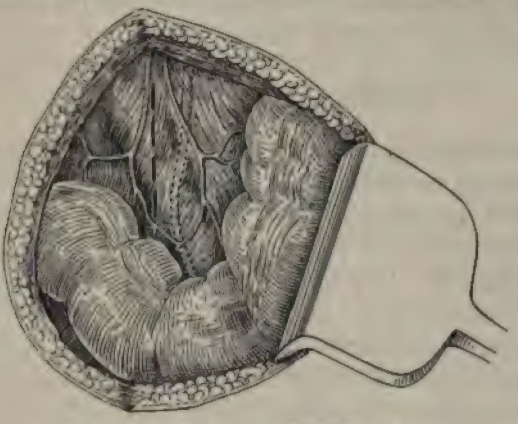


FIG. 956.—Exposure of left iliac artery.

When the meso-sigmoid is penetrated as described, the floor of the sigmoid fossa is reached and the rest of the operation becomes the same as on the right side, except that the whole work must be accomplished through the rent or gap made in the meso-colon.

LIGATION OF COMMON ILIAC ARTERY

Sulzenbacher (Zentralbl. für Chir., 1882, No. 23) collected 50 cases among which there were 12 operative successes. The operation is therefore justifiable in certain grave conditions, *e.g.*, of pelvic enchondroma, etc. As the common iliacs are exposed during ligation of the internal iliac vessels the same method may be used. Chalier and Murard (Rev. de Chir., Feb., 1912) advise the following method for ligation either of the right or left vessel.

1. Trendelenburg's position. Median incision from just above the umbilicus to near the pubis.

2. Usually the vessels can be seen and felt so clearly through the peritoneum that the rest of the operation is easy. But (*a*) the transverse portion of the duodenum may occasionally lie so low that it interferes. If this is the case, a cautiously made incision through the peritoneum below the duodenum permits its mobilization exactly as its descending portion may be mobilized in Finney's gastro-duodenostomy or Vautrin's exposure of the retro-duodenal choledochus; (*b*) the mesentery and the pelvis meso-colon, both very vascular and sometimes connected by a mesenteric meso-colic ligament, may interfere. This difficulty may be overcome as follows: Carefully incise the posterior parietal peritoneum vertically in the middle line from a point just above the promontory of the sacrum upwards for 2–3 finger-breadths, *i.e.*, up to or above the bifurcation of the aorta.

Care is required so as to avoid injuring the left common iliac vein which crosses the body of the fifth lumbar vertebra obliquely, lying in the crotch of the bifurcating aorta. Through the peritoneal wound, dissecting with a director and blunt forceps, one can raise the peritoneum to right or left and with it the root of the mesentery or of the meso-colon and so expose the artery to be tied. In this operation the ureter is out of danger.

EXTERNAL ILIAC ARTERY

(A) **Transperitoneal Operation.**—The external iliac artery may be exposed high up by the same method as is described for the internal. If it is desired to ligate the vessel at a lower level, it is easy to expose it through the abdomen and place a ligature round it at any level.

(B) **Extra-peritoneal Operation. Cooper's Method.**—*Step* 1.—From a point 1¼ inches external to the pubic spine and about ½ inch above Poupart's ligament make an incision parallel to the ligament to a point opposite the junction of the middle and outer thirds of the ligament. Continue the incision in a curve upwards to a point one inch above the internal to the anterior superior spine. Be sure that the incision is large enough. Divide the abdominal wall layer by layer until subperitoneal fat is reached.

Step 2.—With fingers and gauze push the peritoneum (unopened) upwards and inwards from the iliac vessels. When the vessels are exposed keep the wound open by means of a broad-bladed retractor. Trendelenburg's posture is a great aid.

Step 3.—The external iliac artery will be felt running along the brim of the pelvis near the inner end of the wound. Open the sheath on its outer side to avoid the vein which lies internal to the artery.

Demonstrate and pull aside the genito-crural nerve which lies upon or near the artery. Pass a ligature around the vessel from the inner side. Tie.

Step 4.—Remove the retractor. Permit the peritoneum to fall back into place. Suture the abdominal wall, layer by layer, as in an operation for hernia.

The usual site for ligation is about 1½ inches above Poupart's ligament.

As a means of temporary hemostasis a temporary ligature or tape or Crile's clamp may be applied to any of the iliac vessels. This was the means adopted by Balch to control the circulation when he performed reconstructive aneurysmorrhaphy on the external iliac artery.

LIGATION OF THE COMMON FEMORAL ARTERY

The common femoral may be ligated:

(*a*) As a preliminary step in amputation of the hip.

(*b*) For hemorrhage resulting from wounds or from disease in Scarpa's triangle.

(*c*) For aneurysm of the superficial femoral high up.

Ligation of the external iliac is usually preferable for many reasons. The operation is rarely indicated. The writer once did it successfully for hemorrhage

after a high amputation of the thigh where the bleeding-point could not be found.

The dangers of gangrene are of course great. In cases of wounds arterial suture to a large extent takes the place of ligation. The common femoral varies in length, but usually extends for about 1½ inches below Poupart's ligament. The line of the femoral (common and superficial) stretches from a point midway between the anterior superior iliac spine and the middle of the pubis, to the inner margin of the internal condyle of the femur (adductor tubercle).

The Operation.—Semiflex the hip and knee. Abduct and rotate the limb somewhat outwards. Locate the artery by means of its *line* and by palpation. From a point one finger's breadth above Poupart's ligament make a 2½ inch incision downwards along the line of the artery. Divide the skin and superficial fascia. Retract or remove any glands, retract or doubly ligate and divide any veins which may overlie the vessel. Feel for the artery just below Poupart's ligament and divide the deep fascia over it. Avoid injuring the crural branch of the genito-crural nerve which lies over the artery. The femoral vein being on the inner side of the artery, pass the ligature from within outwards. Place the ligature as remote as possible from any branches of the artery.

Ligation of the Superficial Femoral at the Site of Election—Apex of Scarpa's Triangle

The operation may be performed: (*a*) for aneurysm low down on the artery; (*b*) for hemorrhage which cannot be treated by more direct means; (*c*) for elephantiasis. The value of the operation in elephantiasis is very doubtful.

The Operation.—Place the limb as for ligation of the common femoral. The line of the artery is the same as that of the common. From a point about 2½ inches below Poupart's ligament make a three-inch incision downwards along the line of the artery. Divide the skin and superficial fascia. Retract and divide, between ligatures, any superficial veins which may be in the way. Split the deep fascia the whole length of the wound. Note the sartorius crossing the lower part of the wound and retract it outwards. Find the artery by palpation. The long saphenous and the nerve to the vastus internus are in contact with the artery; avoid them. Open the sheath of the artery on its outer side. The vein lies to the inner side of, and behind the artery, therefore pass the aneurysm needle from within outwards and, as the vein has often been damaged during this step, be most careful to hug the artery with the point of the instrument.

Jacobson advises, when the vein is injured, to make pressure on the vein at the lower angle of the wound and then to ligate the artery at a point either above or below the site originally intended, but by no means to persist in attempting to finish the ligation where the accident occurred.

CHAPTER LXIV

OPERATIONS ON VEINS

Most of the operations on veins are so similar to those on arteries that no special description of them is necessary; a few, however, demand more particular consideration.

WOUNDS IN VEINS

When a small vein is wounded, the best treatment is, of course, to stop the bleeding by the pressure of a compress or forceps or by the application of a ligature. When a larger vein is completely divided, the same treatment is proper. Occasionally a vein is wounded in such a location that it is impossible to apply a ligature; in this case the bleeding may be stanched by packing the wound with gauze, or a forceps be applied and left in place for from twenty-four to forty-eight hours or longer. During operation in various localities, notably the neck and axilla, a large vein may easily be wounded by accident or design. The wound may be picked up in the jaws of an artery forceps and a ligature applied laterally, so that the wound is closed, while circulation continues in the vein whose calibre is of course considerably diminished.

Schede improved on the above treatment by closing the wound with sutures. He used thin catgut introduced by fine Hagedorn or, better, rounded or intestinal needles. The swelling of the catgut after it has been introduced closes the needle punctures and prevents escape of blood through them.

The method of suture employed is the ordinary continuous stitch, including in its bite all the coats of the vein. Bleeding is prevented during suturing by finger or sponge pressure applied above and below the wound, or by forceps attached close to the wound itself. In the hands of Schede, venous suture has never failed in giving satisfaction.

In removing a cancerous kidney Schede threw an elastic ligature around the pedicle and included a portion of the vena cava in the ligature. On examination of the pedicle it was found that the walls of all the vessels were diseased and individual ligation was impossible. It was impossible to leave the elastic constrictor *in situ*. "Under careful compression of the vena cava, above and below, by means of spongesticks, the ligature was removed. Violent hemorrhage took place from the opposite renal vein. The wound in the vena cava was quickly closed by two artery forceps so placed that their blades surrounded the wound by converging from above and below, their points meeting near the middle of the vena cava. Bleeding ceased and the remnants of the tumor could be removed. A hole about 3/4 inch in length was found in the vena cava. This was sutured. The forceps were removed. There was no bleeding." The patient lived for thirteen days. Postmortem, narrowing of the vena cava was

found at the site of operation, the wound was solidly healed, the intima was smooth, and there was not the slightest trace of thrombosis. Damar Harrison has had a similar experience.

J. Petit (ref. Journ. de Chir., Aug., 1912) finds that 50 per cent. of the published cases of wounds of the inferior vena cava occurred during operations for renal cancer. Treatment by permanent tamponade need not be considered as its results are deplorable. Forcipressure by leaving hemostats *in situ* gave 2 recoveries in 7 cases; lateral ligature 2 recoveries in 3 cases. This method "should be reserved for cases of tearing of the renal vein when a short pedicle exists convenient for ligation." In 14 cases of complete ligation of the vena cava there were 6 deaths. After ligation "the circulation in the lower limbs is rarely troubled, in but 3 cases was there œdema and that soon disappeared in two of them. Ligation then may be employed in wounds situated below the renal vein." Lateral suture is the treatment of choice; in 19 cases of lateral suture there were only 2 deaths. When the lesion is *above* the renal vein, lateral suture should be attempted in every case. Below the renal vein lateral suture should be done except when the operation has been too prolonged; when the wound is infected or when the wound is irregular and transverse.

Eloesser (Jour. A. M. A., Jan. 30, 1915) in excising a cancer had to cut away part of the femoral vein. The patient was 78 years of age, the veins were thick and sclerotic. Hemorrhage was temporarily stopped by pressure. "A bit of fatty tissue removed from the wound in the groin was tacked over the opening in the vein by a fine silk stitch which did not pierce the vein itself, but passed through the adjacent tissue and was crossed over the graft. On releasing the pressure there was no further bleeding." Death ensued in 12 days from senile delirium. The graft had united, was not necrotic and there was no clotting of blood in the vein.

1. Intravenous injection of salt solution.

The solution most commonly used is .75 per cent. or .6 per cent. solution of common salt in sterile water. Usually the sterilization is accomplished by boiling, but a fatal infection due to *bacillus capsulatus aerogenes* (this organism resists boiling most remarkably) leads some surgeons to insist that sterilization by compressed steam be the rule.

A "rough and ready" method of preparing the salt solution is to add a teaspoonful of salt to a pint of water and to boil the solution. The water used must be free from floating particles. When the intravenous injection is given because of shock "adrenalin" may be added to the salt solution (1:20,000).

The principal indications for intravenous infusion of salt solution are shock and hemorrhage. Hypodermoclysis and proctoklysis have largely taken the place of intravenous infusion.

Step 1.—Apply a bandage around the upper arm tightly enough to cause some distention of the superficial veins. Choose the most prominent and most convenient vein, usually the median basilic. Expose the vein by an incision 1½ inches in length along the long axis of the vein or obliquely across it. Isolate about 1 inch of the vein.

Step 2.—Surround the vein with two catgut ligatures about 1 inch apart. Tie the lower ligature.

Step 3.—Make an incision from below upwards, involving about half the thickness of the vein in such fashion that proximal side of the wound forms a V-shaped flap. Catch the point of the flaps in forceps and slide under it into the vein the end of the blunt-pointed cannula (Fig. 957). The cannula must be directed upwards. Tie the catgut ligature, already in place around the cannula, in a single knot. (An ordinary glass pipette such as is sold for dropping solution into the eye or for filling a fountain pen makes as good a cannula as any.) Remove the constricting bandage from the arm. The cannula must already have been connected with a funnel (or fountain syringe) filled with salt solution at a temperature of 100°–110° F. As the cannula is being introduced, solution ought to be flowing from it, otherwise air may enter and do harm.

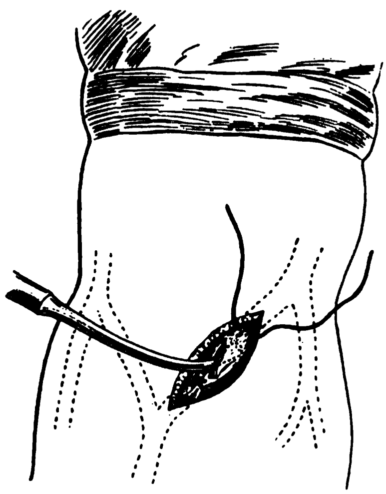


FIG. 957.—Intravenous injection.

Step 4.—Permit the warm salt solution to flow into the vein. Watch the patient's respiration and heart action. Any sign of pulmonary œdema or cardiac embarrassment calls for immediate stoppage of the infusion. From a pint to a quart or more of the solution may be introduced in the course of thirty of forty-five minutes. Remember that when shock is very profound one can easily and uselessly introduce vast quantities of salt solution which passes into the dilated abdominal veins and may transude into the intestines, etc.

Step 5.—As soon as the transfusion is finished, remove the cannula. Tie the proximal segment of vein. Close the skin wound.

Of course any superficial vein, *e.g.*, the internal saphenous near the ankle, may be used in place of the median basilic.

Direct Transfusion of Blood.—Direct transfusion of blood was more or less popular many years ago, but was given up in favor of salt solution because of technical difficulties, and because of the belief that what was required was *not* blood, but a bland, isotonic circulating medium. Advances in the technic of arterial surgery led Crile to make experimental researches in direct transfusion, and he has found it to possess many advantages in cases of shock and of hemorrhage. Furthermore, he has used it in the postoperative treatment of cancer, hoping thereby to raise the resisting power of the patient to the unknown cause of cancer.

Transfusion Cannula.—Numerous cannulas have been devised to aid in transfusion. The original one (Fig. 958) was devised by Mixter and adopted by Crile. Others will be mentioned later in this chapter.

The Operation.—Arrange recipient and donor on parallel operating tables, the head of the recipient being opposite the feet of the donor. Between these two tables arrange a movable table to support the left arms of the victims. The surgeon and assistant seat themselves *vis-a-vis* at each side of the movable table and between the two operating tables. Produce local anesthesia with novocaine. (It is often well to give to both patients morph. gr. 1/4 about thirty minutes before operation.) Expose the donor's radial artery for about 3 cm. (1 1/4 in.). Attend carefully to hemostasis using fine clamps (mosquito forceps). Retract all nerve branches and venæ comites. Isolate the artery neatly. Ligate the distal end of the artery and apply an arteriorrhaphy clamp to the proximal end. Divide the artery with sharp scissors; pull the adventitia well over its cut end and snip it off closely. This leaves a clean open end to the vessel. If the lumen contracts too much, dilate it with a vaselinized mosquito forceps. On the recipient expose and isolate a convenient superficial vein. Ligate its distal and clamp its proximal end. Divide the vein near the ligature exactly as was done to the artery. Grasp the Mixter cannula (dipped in sterile vaseline or oil) with a hemostat and push the vein through it. Grasp the edges of the vein with suitable forceps, turn it back as a cuff over the cannula and tie it in position with a fine ligature around the cuff at the second groove of the cannula. With mosquito forceps catch the end of the artery at three points and push into its lumen the cannula which is covered by the venous cuff. Tie the artery in place by a fine ligature. Loosen the arteriorrhaphy clamp from the vein and then from the artery. At first the flow of blood is very slow because of arterial contraction, but a liberal application of warm salt solution soon causes dilatation and the stream grows larger, reaching its maximum in about ten minutes.

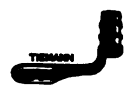


FIG. 958. Crile-Mixter cannula.

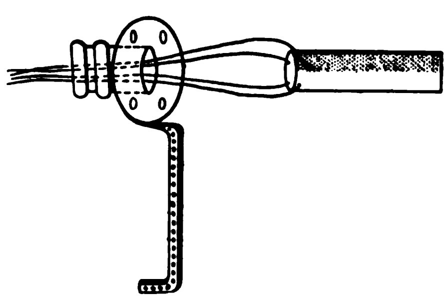


FIG. 959.—(*Hepburn.*)

Hepburn ("Annals of Surg.," Jan., 1909) modifies Crile's cannula so as to render the necessary manipulation less difficult. The flange of the cannula is provided with four perforations (Fig. 959). By means of four threads the vein is pulled through the cannula (Fig. 959); the threads are passed through the perforations in the flange (Fig. 960) and by traction on them it becomes easy to evert the vein over the cannula (Fig. 961) where it can be fixed by a ligature. In similar fashion provide the open end of the artery with four thread tractors;

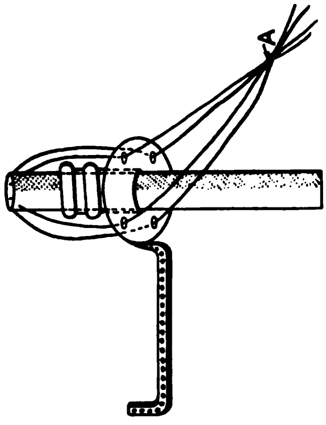


FIG. 960.—(*Hepburn.*)

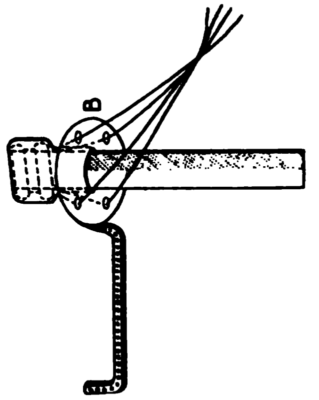


FIG. 961.—(*Hepburn.*)

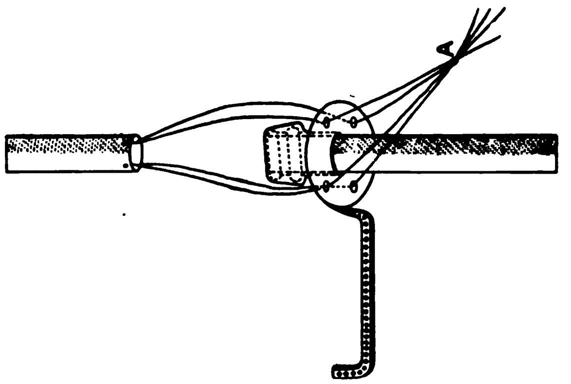


FIG. 962.—(*Hepburn.*)

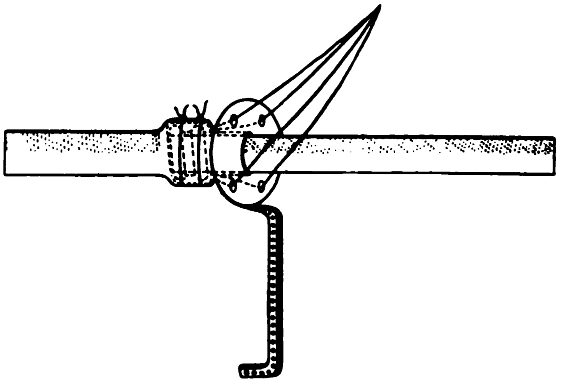


FIG. 963.—(*Hepburn.*)

:hreads through the perforations in the flange and by traction on the ıll the artery over the cannula. With a ligature tie the artery to the Figs. 962 and 963).

ıth's simplified technique is sufficiently shown by Figs. 964, 965, 966. ı, Journ. A. M. A., Jan. 3, 1914.)

eim's Method.—Bernheim uses a two-pieced silver cannula made in It is not necessary to wax or vaselinize these before use: "(1) Expose with its accompanying veins for a distance of about two inches; (2) tery from the veins and tie off all branches doubly with very fine silk, tween the ties; (3) tie off the artery doubly at the distal end of the d cut between ties, thus allowing about one and one-half inches of the

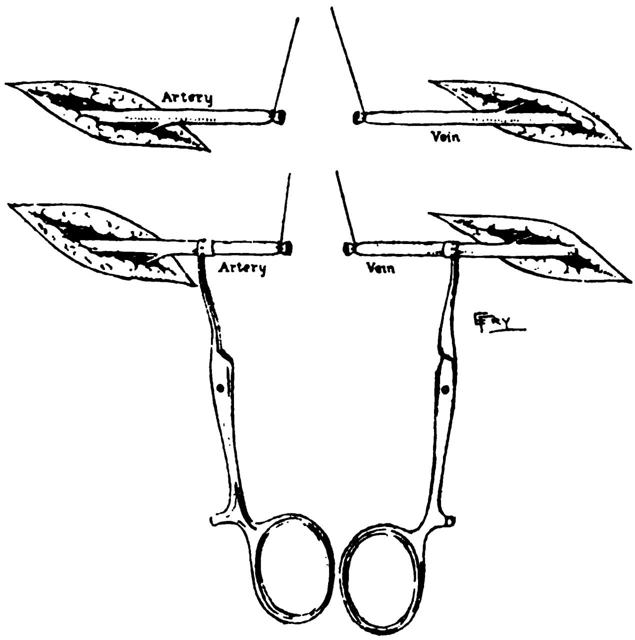


FIG. 964.—(*McGrath, Journ. A. M. A.*)
nds of artery and vein pulled by threads through the rings of McGrath's forceps.

ie free in the wound; (4) tie off all bleeding points in the wound, and ıstant stream of warm salt solution flowing over the artery, all spong- done with gauze moistened in the same solution; (5) place a bull-dog the vessel at the proximal end of the wound."

a small cut in the upper side of the artery with fine scissors, the open- nade at right angles to the course of the vessel and about half its width. solution wash out every trace of blood and at frequent intervals during ıg inject liquid vaseline into the lumen with a medicine dropper. Re- tags of adventitia. Introduce the bevelled end of the male half of the ie it in place; inject through it some liquid vaseline. Wrap wound ıla in warm moist gauze. Dissect free about one inch of vein in the

recipient and introduce into it the female half of the cannula. Bring together the tables or stretchers on which the patients lie and place the two arms on a table about one foot wide. The position of the two arms is shown in Fig. 967 (Bernheim). Unite the tubes. Keep a stream of warm salt solution flowing over the wounds and tubes. Remove the clamp from the vein but occlude the vein with a finger. Gradually remove the clamp from the artery and lessen

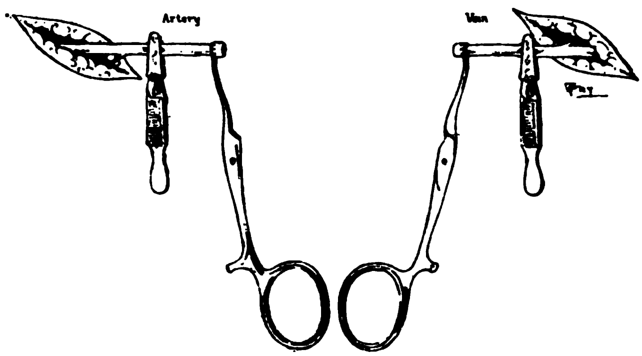


FIG. 965.—(*McGrath, Journ. A. M. A.*)
The ends of the artery and vein are reflected back as cuffs over the rings of the forceps.

the finger pressure on the vein, thus letting the blood through slowly and preventing embarrassment of the recipients circulation by a too sudden influx of blood. This is important and the control should be kept up during the whole transfusion as the margin of safety is none too great.

It is difficult to judge of the amount of blood passing over. The blood pressure is not a very valuable index because of emotion, etc. The general appearance

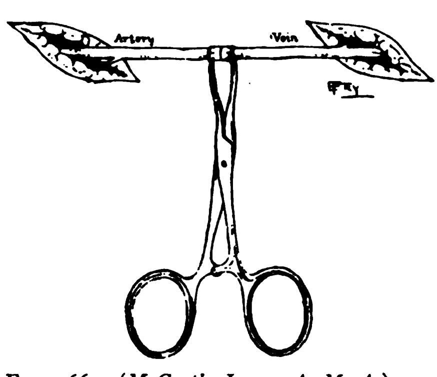


FIG. 966.—(*McGrath, Journ. A. M. A.*).
Forceps connected to the ends of the vessels brought into contact, intima to intima.

and sensations of both donor and recipient are the most useful signs of the progress and safety of the operation. For most transfusions the average duration of the flow is from twenty to forty minutes. Bernheim in exsanguinated recipients tries "to bring a pulse of say 150 to 160 down to about 100 and to raise the blood pressure of 50 to 70 up to 110 or 120, figures well within the zone of safety."

Saxton Pope (Journ. A. M. A., April 26, 1913) uses as a cannula two short glass tubes slightly flared at the point and united by a short segment of rubber catheter. He boils the apparatus in equal parts of white petrolatum and paraffin to provide an internal coating. In view of the observations of T. L. Deavor (Am. J. of Surg., Jan., 1915) this troublesome precaution may perhaps be omitted as Deavor finds that by keeping the vessels and apparatus warm and moist with salt solution no coagulation takes place. Very many varieties of cannula have been devised for transfusion, but simplicity will prevail.

Cooley and Vaughan (Journ. A. N. A., lx, p. 435) having failed to accomplish the Crile method of direct transfusion completed their work as follows: A constrictor was applied to the donor's arm sufficiently to cause dilatation of the superficial veins. Into one of these veins they inserted a sharp needle attached to a 10 c.c. syringe and filled the syringe with blood. The median basilic vein of the recipient had already been exposed and opened; a blunt needle was inserted into it and to this the syringe was attached and the contained blood injected. Another 10 c.c. was obtained and injected in the same way. Cooley and Vaughan advise the use of two sets of syringes and needles so that while one set is being used the other may be washed out in salt solution; they further advise that the injection of blood be followed by one of salt solution.

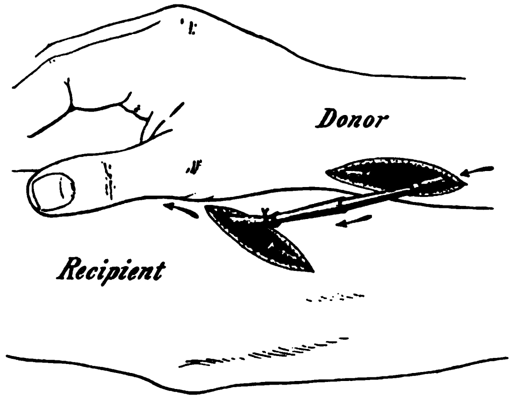


FIG. 967.—(*After Bernheim.*)

DIRECT VEIN-TO-VEIN TRANSFUSION

Dorrance and Ginsburg ("Jour. A. M. A.," Aug. 13, 1910) advise direct "vein-to-vein" transfusion. A. M. Fauntleroy ("Med. Record," Sept. 3, 1910) has used Brewer's tubes slightly modified for the same purpose. The method has this great advantage over "artery-to-vein" transfusion that it is exceedingly simple and the special apparatus (the tubes) can be quickly made from inexpensive materials.

Preparation of Tubes.—Take a segment of thin glass tube about 3 inches long and ⅛ inch inside diameter. Cut the ends square. Heat the ends and when hot push into them a piece of pointed metal (a sharp-pointed wire nail will do). This presses outwards the edge of the glass and makes a small flange. Heat the tubing and bend it into the shape of a wide **U** or of an **S**. Both shapes are useful. The **S** tube is necessary during arm-to-arm transfusion when the arms of the donor and recipient are lying side by side with the hands pointed in the same direction (Fig. 968); the **U** tube is necessary when the donor's hand is pointed towards the shoulder of the recipient. Sterilize the tubes by boiling; drop them in melted paraffin; pick them out with sterile forceps and shake all excess of paraffin out of their lumen; lay in sterile gauze to cool and then wipe away the paraffin on their outer surfaces.

Probably the Sexton Pope or the Deavor cannulas would be better because less breakable.

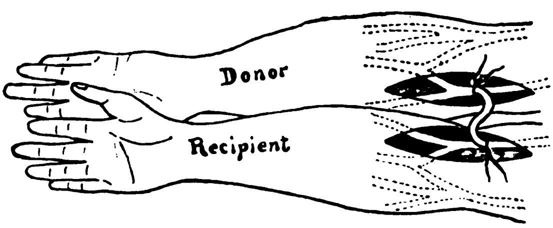


FIG. 968.—Vein to vein transfusion. (*Fauntleroy.*)

The Operation.—If the median-cephalic or median basilic veins are chosen for the operation proceed as follows:

Surround the arm of the recipient, above the site of operation, with a bandage sufficiently tightly to make the peripheral veins prominent. Expose the chosen veins for about one inch. Pass two ligatures round the vein, one in the upper and one in the lower angle of the wound. Tie the *lower* ligature. Remove the constricting bandage. Similarly expose and pass ligatures round the vein of the donor and tie the upper ligature. Temporarily occlude the lower segment of vein by Crile's clamp or its equivalent. Divide or open the vein far enough above the clamp to permit the introduction of one end of the glass tube. Introduce the tube into the lower segment of vein, and tie the lower ligature, thus holding the flanged end of the tube in the vein. Bring the arm of the donor alongside that of the recipient; open the vein of the recipient. Bring the free end of the tube (already connected with the donor) close to the recipient's vein; release the Crile's clamp and let the blood flow from the donor and escape through the glass tube. Insert the free end of the glass tube into the vein of the recipient and fasten it by tying the ligature already in place. The bandage which constricts the arm of the donor is left in place so as to keep so much pressure in the veins that the blood will flow freely from donor to recipient; the bandage must not of course interfere with the arterial circulation.

When the transfusion is completed, remove the tube, ligate the open veins and close the wound.

INDIRECT TRANSFUSION

Simple Syringe Transfusion (Lindeman, Am. J. Dis. of Children, July, 913).—Lindeman thus describes the operation:

"The entire apparatus for simple syringe transfusion consists of two sets f cannulas, two tourniquets and twelve syringes.

"*Cannulas.*—Two sets of cannulas are employed, one for the donor, the other for the recipient (Figs. 969 and 970).

"There are three cannulas to each set (Fig. 970; 1, 2, 3,). Each cannula telescopes within the other as shown in Fig. 969.

FIG. 969.—(*Lindeman.*)

"The innermost cannula is practically a hollow needle, 2 9/16 inches long, gage, with one end ground to a fine point and short bevel.

"The hollow needle (1, Fig. 970) is fitted snugly into cannula 2. Cannula 5 mm. shorter than the needle and is fitted snugly into cannula 3. Cannula 5 mm. shorter than cannula 2. The proximal ends of 1 and 2 are capped n stationary thumb-screw caps.

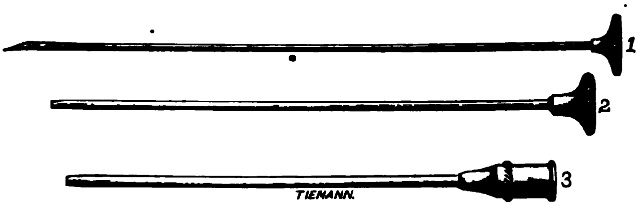


FIG. 970.—(*Lindeman.*)

"The proximal end of 3 is capped with a receiver to fit any Record syringe.

"Cannula 3 is 2 inches long, 14-gage, .064 diameter. The caliber of this annula is the same as the tip of a Record syringe.

"In very small infants with very small veins only cannulas 1 and 2 are mployed, 2 being capped with the receiver to fit tip of syringe.

"The syringes used are Record syringes of new improved type with a capacity of 20 c.c. and can be sterilized by boiling.

"*Operation.*—One operator manages syringe of recipient. Another operator manages syringe of donor. An assistant stands between operators, who re in a position close to the assistant. Donor and recipient are placed in the cumbent position. Suitable veins are selected.

"In adults and most children over 2 years of age the median basilic is sily accessible. In infants the external jugular or one of its tributaries is tered more advantageously. In some cases the internal saphenous may prove e vein of preference.

"A tourniquet is placed in position, and the skin is sterilized with iodin. The cannula is then held in a position almost parallel to the vein with the thumb on the thumb-screw cap of the innermost cannula (1, Fig. 969). The skin is then punctured and the cannula is forced into the vein. After the first joint A has entered vein, cannula 1 is withdrawn a distance of about one-half inch (this prevents the vessel wall from being injured or punctured by the needle after the vein is entered).

"With the thumb now on the thumb-screw cap of 2 the cannula is forced further in until the second joint B (Fig. 969) has entered the vein. Cannula 2 is then withdrawn a distance of about one-half inch (cannula 3 alone can come into contact with the vessel wall). Cannula 3 is then gently pushed into the vein to a desirable length; usually three-quarters to one inch will suffice.

"Cannulas 1 and 2 are now withdrawn entirely. If the vein has been successfully entered, blood will flow through the cannula. When the first drop appears, a syringe containing warm saline solution is immediately attached and a very slow flow of saline is maintained through cannula. Escape of blood is thus prevented.

"There is no need of haste at this stage.

"A cannula is next inserted in vein of donor in a like manner; again a syringe containing warm saline is attached and loss of blood thus prevented. Everything is now in readiness for the transfusion.

"An empty syringe is substituted for the one containing saline solution, and blood is withdrawn from donor as rapidly as possible.

"When the syringe is full the assistant passes it to the operator on the recipient, who removes its saline syringe, attaches the syringe containing blood and evacuates the contents gently but speedily into the vein.

"One syringeful of blood is followed by another in rapid succession until the desired quantity of blood has been transfused.

"A little normal saline is injected through cannula of recipient after each syringeful of blood. This keeps the cannula free of blood and precludes the possibility of clotting.

"It has been found advisable for the assistant (or third man) to remove the syringe from the cannula of the donor as soon as filled.

"The operator can thus hold the cannula in place with one hand while with the other hand he may at once adjust an empty syringe into the cannula. Loss of blood is thus reduced to a minimum.

"*Rules.*—1. Bright polished surfaces of syringe and cannulas are requisite.

"2. A syringe used once should not again be employed until thoroughly cleansed with sterile water.

"3. Air must be avoided. This, however, offers no difficulty.

"4. Tourniquet of patient must be removed after vein is entered with cannula.

"5. Tourniquet remains on donor throughout operation; momentary release of tourniquet may be advisable once or twice during course.

"6. Dexterity and speed are requisite for success.

"7. Syringes can be evacuated more rapidly than they can be filled without any harmful effects. This difference in time allows attachment of syringe with warm saline following each syringeful of blood.

"*Comments.*—The time elapsing in filling and evacuating the syringe is so brief that blood does not undergo any alteration from donor to recipient.

"No lubricant has been employed except in one case. Cannulas are lined with a film coating of albolene.

"Both arms of the donor may be used simultaneously.

"Larger syringes with larger calibred cannulas may be used, but the present sizes have worked satisfactorily and fittings of syringe and cannulas are of universal gage.

"Syringes and cannulas may be kept sterile in individual metal containers. They are thus in readiness for immediate use and no preparation for operation is required.

"The same vein can be used repeatedly for subsequent transfusions, since no thrombosis nor permanent injury to vessel occurs.

"Any quantity of blood can be transfused and the quantity definitely measured at the time of transfusion."

Kimpton and Brown Method (Journ. A. M. A., July 12, 1913 and personal communication).—Apparatus required: (1) Kimpton-Brown tubes of 150 c.c. and 250 c.c. capacity (Fig. 971); (2) Vincent's mixture, viz., stearin 1; paraffin 2; vaseline 2; (3) cataract knife; (4) a very small-angled forceps shaped like Murphy's intestinal clamp. The blades of this forceps introduced into a collapsed vein aid greatly in the insertion of the cannula.

"The tubes, having first been thoroughly cleansed, are wrapped in sheet wadding and towel and sterilized in an autoclave. The paraffin mixture is likewise sterilized. To coat the tubes they are opened in aseptic manner and equally heated over an alcohol flame, then a considerable amount of melted paraffin is poured into the tube and rolled around the cylinder, covering the entire surface. Some is allowed to run out the cannula end and then the tube is tipped up, cork end down, allowing all the paraffin to run back out of the cannula end and escape through the side-tube. This leaves the cannula clear. The tube is now re-wrapped in its sterile covers and is ready for use. They are easily cleaned by allowing boiling water to run through them form the tap with the aid of tincture of green soap. If not thoroughly cleaned they will not take the paraffin coating well."

"The skin over a vein just below the elbow in the arm of the donor is injected with novocaine. While waiting for the effect of the novocaine the skin over the vein of the recipient is likewise injected, using novocaine one-half of one per cent. Going back to the donor, the vein is exposed cleanly through an incision not more than 1½ inches long. Two ligatures are placed under this vein, but not tied, one above and one below. Now the recipient's vein is treated in the same manner. A tourniquet is now placed on the donor's arm tight enough to give venous congestion and still allow arterial blood to flow in.

This vein is now tied off proximally, and the distal ligature is left to be used as a clamp by merely raising it a little after the vein is open. The donor's vein is now transfixed by a cataract knife and a slit made. The cannula of a tube is now inserted into the vein of the donor and held upright until filled by venous pressure. This usually takes not over two or three minutes for a 250 c.c. tube. If not filling well, it usually means that the tourniquet is too tight or that the end of the cannula is against a valve or the side of the vein. The donor is instructed to shut and open his hand tightly and slowly. This, perhaps, hastens the inflow. While the tube is filling, the vein of the recipient (without the use of a tourniquet) is tied off distally, the proximal ligature being used as a clamp, and the vein opened. By this time the tube is full and is withdrawn and held

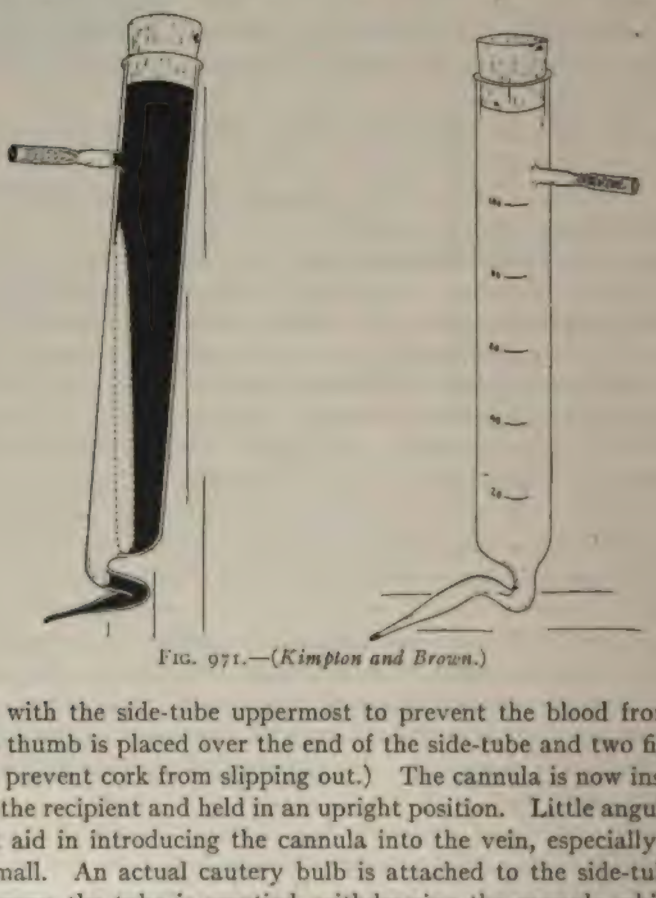


FIG. 971.—(*Kimpton and Brown.*)

on its side with the side-tube uppermost to prevent the blood from running out. (The thumb is placed over the end of the side-tube and two fingers over the cork to prevent cork from slipping out.) The cannula is now inserted into the vein of the recipient and held in an upright position. Little angular forceps are a great aid in introducing the cannula into the vein, especially when the lumen is small. An actual cautery bulb is attached to the side-tube and by a little pressure the tube is emptied, withdrawing the cannula while there is still blood left in it. More tubes may be filled and emptied as needed, using the same veins. While emptying the tube the thumb is placed under the side-tube at its junction with the cylinder and the index finger over the cork."

Infective Phlebitis.—For many years it has been customary to ligate the internal jugular vein to prevent dissemination of infection in cases of sigmoid

sinus thrombosis. The same treatment is applicable in acute thrombophlebitis in other localities. The principle of the operation is to ligate the vein at a point above the thrombus and then to open and clean out the vein where it is diseased, or still better to excise the diseased segment. Trendelenburg records a case of general chronic puerperal infection which recovered after double ligation of the inflamed and thrombosed right hypogastric (internal iliac) and spermatic veins. The details of the operation required are practically the same as for similar procedures on the arteries.

Varicose Veins.—The excuse for the superficial veins of the leg becoming varicose is that being outside the deep fascia they are poorly supported.

The principle of treatment of varicose veins is the transference of the venous circulation from the superficial to the deep veins, but before attempting to do this it must be shown that there is neither thrombosis of the deep veins nor marked obstruction to the return of blood through them. It must be remembered that varicosed superficial veins may be nature's means of dodging obstruction of the deep vessels.

Mayo, in doubtful cases, applies an elastic support to the limb for a week; if this gives comfort it is fairly evident that the deep vessels are capable of doing their duty.

Trendelenburg, struck by the fact that regurgitation of blood takes place from the deep femoral into the long saphenous vein, doubly ligated and divided the latter close to the saphenous opening. The operation is a good one when the condition is due to regurgitation. The test for regurgitation is as follows: (1) Elevate the limb until the veins empty themselves. (2) Make pressure over the vein near the saphenous opening. If the superficial veins now quickly become prominent Trendelenburg's operation will probably be inefficient. (3) The veins have not become prominent; still keeping up pressure at the saphenous opening, let the limb hang down. Remove the pressure. If a column of blood passes *down* the vein, Trendelenburg's method will probably be efficient.

Trendelenburg's Operation.—Local anesthesia usually suffices. Place a rubber band around the upper part of the thigh sufficiently tightly to cause dilatation of the superficial veins. This precaution may be dispensed with if desired. At the junction of the upper and middle thirds of the thigh make a longitudinal incision about one and one-half inches in length along the course of the vein. A transverse incision is preferable in fat patients. Expose and isolate the vein; ligate it with catgut at the upper and lower ends of the wound; excise the portion lying between the ligatures. Close the wound with sutures. Dress. Repeat the above procedure at a point immediately below and one immediately above the internal condyle. Keep the limb at rest for from two to three weeks. When painful varicose tumors are present, the author always supplements the Trendelenburg operation by excising such.

Delbet's Operation.—As Trendelenburg noted, varicosity of the long saphenous vein is due to inefficient valve action at its junction with the femoral, thus the whole weight of the blood in the inferior vena cava comes to bear on the saphenous vein. Below the junction of the two veins valves exist in the femoral

vein. Hesse and Schaak found these valves constant in a hundred subjects and that while they were usually present 3 to 4 cm. ($1\frac{1}{8}$–$1\frac{1}{2}$ in.) below the junction yet occasionally they were 7 to 10 cm. ($2\frac{3}{4}$–4 in.) below. If the saphenous vein is doubly ligated and divided high up as in Trendelenburg's operation and its lower segment is anastomosed to the femoral vein below the site of the valves then there can be no serious reflux of blood and yet circulation through the saphenous vein is not impeded or prevented as is the case after most of the classical operations. The operation consists in isolating and ligating the long saphenous vein at its upper end and in making an end-to-side anastomosis between the lower segment of the saphenous and the femoral veins, *i.e.*, uniting the open end of the saphenous vein to the sides of a suitable incision made in the femoral vein. As in 73 per cent. of patients the femoral valves are situated close to the normal sapheno-femoral junction Delbet establishes the anastomosis 4–5 cm. ($1\frac{1}{2}$–2 in.) below that point while Hesse and Schaak prefer to make it 10 cm. (4 inches) below the junction, *i.e.*, about 20 to 25 cm. (8–$9\frac{3}{4}$ in.) below Poupart's ligament. Felbet has had excellent results in 25 cases while out of 23 cases Hesse and Schaak lost one from severe streptococcic infection. To the author venous anastomosis seems entirely too serious an operation for varicose veins and that much simpler measures give very satisfactory results.

Cecca's Operation.—In certain uncomplicated cases of varicose veins where the long saphenous presents no old secondary lesions and where its branches are not extensively dilated, R. Cecca (Ref. "Journal de Chir.," i, No. 9) suggests giving support to the diseased vessel by transplanting it under the fascia. The operation consists of exposure of the vein by a long incision—incision of the fascia—insertion of the vein through the long wound in the fascia—suture of the fascia over the vein—closure of the skin wound.

Katzenstein performs an operation very similar to Cecca's. Through a long incision isolate the long saphenous vein and its affluents; isolate the sartorius; place the vein under the muscle applying a few sutures to the borders of the muscle. "The saphenous vein is thus imprisoned in a contractile muscular tunnel and while the varices in the leg do not completely disappear yet the pain disappears, the leg loses its feeling of weight and the patients state that they are relieved."

Phelp's Operation.—Multiple subcutaneous ligation. Pass a handled needle with its eye near the point, through the skin, behind the vein, and out through the skin on the opposite side of the vein. Thread the needle with stout silk; withdraw the needle and unthread it. Through the same puncture reintroduce the needle; pass it in *front* of the vein and out through the skin puncture on the opposite side of the vein made in the previous movement. Thread the free end of the silk ligature in the needle and withdraw the needle. By the above means a silk ligature has been made to surround the vein, and its ends emerge through the same puncture in the skin. Tie the ligature tightly. Repeat the operation at about thirty or forty places. Apply dressings and prescribe rest in bed.

Mayo's Operation.—C. H. Mayo excises the long saphenous vein as follows: Expose and isolate the vein near the saphenous opening. Divide the vein between ligatures. Seize the peripheral portion of the vein with a hemostat.

Pass the end of the vein through the loop of Mayo's dissector (Fig. 972, *a*). Guided by the vein push the dissector under the skin down to a point near the knee; cut through the skin over the end of the dissector; clamp the vein, pull it out through the wound, ligate and excise the loose portion. If the dissector is obstructed in its work by adhesions around the vein, pass the closed forceps (Fig. 972, *b*) alongside it, and when the adhesions are reached open the blades

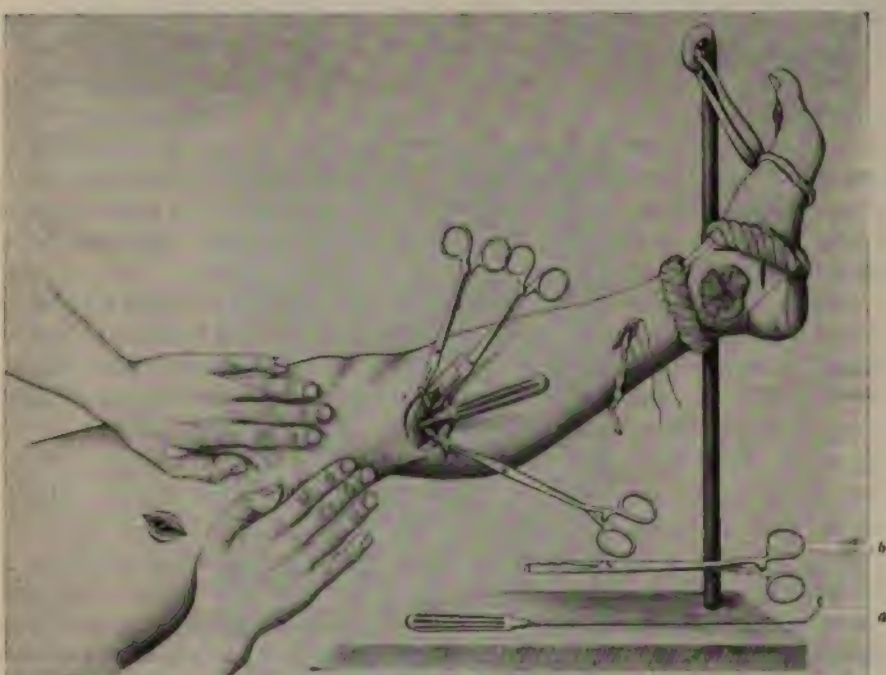


Fig. 972.—Excision of varicose veins. (*Mayo.*)

of the forceps slightly; this usually overcomes the trouble and the dissector can complete the work. In the same manner remove, subcutaneously, as many other veins as may be necessary. The dissection should be from above downwards to avoid the danger of detaching thrombi and throwing them into the circulation.

Removal by Inversion.—W. L. Keller's operation ("N. Y. Med. Journ.," Aug. 19, 1905). Elevate the limb. Expose the long saphenous vein near the saphenous opening. Divide the vein between clamps. Ligate the proximal stump. Split the upper end of the distal segment for about three-quarters of an inch on its anterior wall. Tie a strong ligature to the upper end of the vein (Mamourian uses a suture), care being taken not to include more tissue in the

ligature than will pass through the lumen of the vessel. Apply traction to the distal stump and thus make the vein prominent along its course as far as the knee. Expose the vein by a small incision on the inner aspect of the knee. Divide the vein between two clamps. Ligate the distal segment. Remove the clamp on the proximal segment and pass a long probe, eye first, up the lumen of the vein until it comes out of the first incision. Thread the ligature on the probe. Pull on the distal end of the probe and so extract the vein at the same time turning it outside in.

Marmourian writes ("Brit. Med. Journ.," July 16, 1910): "All the prominent veins of the leg can be dealt with in similar fashion. If they are very tortuous, a gum-elastic catheter should be used instead of the probe. The method is not applicable to cases of general or cirsoid varicosities."

Babcock's Operation. ("Journ. A. M. A.," July 16, 1910.)—Babcock has improved an operation which he published in 1907. A special instrument required is a long, pliable probe with a small acorn tip at one end capable of passing through the lumen of the vein to be removed; at the other end is a larger acorn tip, the shaft surface of the acorn being so cuffed as to catch the wall of the vein and prevent its inversion and slipping over the end of the instrument.

Expose the vein either at the upper or lower end of the segment to be removed (preferably the upper end, to obviate dangers of embolism (J. F. B.)). Grasp the vein with a hemostat. Incise the vein and introduce the smaller end of the probe. Pass the probe along the inside of the vein for the required distance or until some obstruction is encountered. With strong silk tie the vein to the shaft of the probe close to its larger acorn end. Divide the vein between the hæmostat and the probe. Replace the hemostat by a ligature. Incise the soft parts including the wall of the vein over the smaller end of the probe which may be felt or seen. Grasp the small end of the probe and pull it out of the wound by firm traction combined with a series of short jerks. The vein comes away pleated firmly in a small fusiform mass against the concavity of the larger bulb of the instrument. The procedure may be repeated on other varicose veins as required.

Excision of Varicose Veins.—*Excision of the whole Internal Saphenous System.*—Make an incision, slightly curved with convexity posterior, from the upper end of the saphenous opening to the posterior border of the internal condyle of the femur. Expose the vein where it dips through the saphenous opening, doubly tie and divide it as high as possible, above the point of entrance of the superficial external pudendal vein (Alglave). If there are varicosities of the superficial abdominal veins Alglave recommends that they also be ligated through an extension of the incision upwards. (The author would be chary of doing this lest the varicosities should happen to be the result of some intra-abdominal venous obstruction.) Reflect the edges of the skin wound widely so as to expose, from above down, the saphenous trunk and its branches. The whole inner side and some of the anterior surface of the thigh is exposed. If there is found a collateral trunk of the vein this must be followed, if necessary,

through a secondary incision. Large varicose branches must also be included in the excision. Grasp the upper end of the vein and, making slight traction on it, dissect downwards. The traction makes all branches prominent so that they are easily clamped and divided. When the lower end of the wound is reached do *not* cut away the mobilized packet of veins. Attend to hemostasis. Suture and protect the major portion of the wound. Continue the incision down the leg to a point in front of the internal malleolus. Below the knee reflect the skin forwards to near the tibial crest and backwards to about the middle of the calf. Putting slight tension on the veins already removed from the thigh, continue the dissection downwards to beside the ankle. Along with the veins remove the surrounding fat and connective tissue, *i.e.*, excise everything between the deep fascia and the skin. Save as many branches of the internal saphenous nerve as possible. Close the wound.

FIG. 973.—Friedel's operation. (*Friedel.*)

If the skin is healthy the above operation is easy but if there are many adhesions and if the skin is thin and much altered it becomes impossible or improper.

If the skin lesion is not extensive it may be best to excise that area of skin along with the veins; if it is extensive and if the dissection is difficult one must be content with excising the main trunks, if necessary removing large varicose branches through separate incisions. It is not always necessary to make a continuous incision from Scarpa's triangle to the ankle. If one desires one may make suitable incisions in the thigh and leg and burrow under the skin

between them opposite the knee. Naturally if the internal saphenous is affected only in the leg the operation on the thigh may be omitted.

Excision of External Saphenous System.—Make an incision through the skin from the middle of the popliteal space to a little above the external malleolus. Remove the vein and its branches in the manner already described.

When limited areas of veins are alone varicose, these, of course, may be excised through any suitable incision.

Schede's Operation.—In the upper third of the leg make an incision completely round the limb, dividing all the tissues down to the deep fascia. As the cut is being made doubly ligate and divide all the veins.

Von Wenzel's operation is the same as Schede's *plus* a similar circular incision at the junction of the middle and lower thirds of the thigh.

Friedel's Operation ("Archiv für klin. Chir.," lxxxvi, p. 143).—When the veins in the leg are not only increased in size but in numbers and repeated attacks of inflammation have so imbedded them in scar tissue that excision is impossible, Friedel's operation gives promise of value. Much œdema is usually present, giving the limb an appearance of elephantiasis—ulcers are almost always evident and the question of amputation arises.

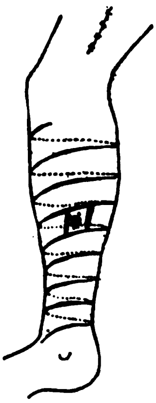


FIG. 974.—Friedel's operation. (*Friedel.*)

The Operation.—*Step* 1.—Doubly ligate and divide the long saphenous high up in the thigh.

Step 2.—With a knife mark a spiral line running round and round the leg from a point below the disease to a point well above it. The closer together the rings of the spiral lie, the oftener will the veins be divided and the greater the probability of cure. When ulcers are present the spiral should surround the leg *both* above and below them. Necrosis of the skin has not developed as a result of the spirals being close together.

Step 3.—Guided by the marks on the skin, make an incision down to the deep fascia. As this cut is made inch by inch, widely retract the edges of the wound and ligate or throw a stitch around each vein which does not stop bleeding under simple tamponade. Continue the cut until it follows the entire length of the spiral traced on the skin in Step 2 (Fig. 973).

Where an ulcer exists join the spirals above and below it by two vertical incisions so as to cut off the veins coming from the ulcer (Fig. 974).

Step 4.—Pack the whole length of the wound so that it must heal by granulation. During the after-treatment destroy all superficial granulations which might fill up the wound before epidermization takes place. It is of importance to have the epithelium spread from the skin down into the depth of the wound so that a very deep permanent spiral gutter is formed giving the leg somewhat the appearance of rolled beef.

The author has used Friedel's operation or some modification of it, with satisfaction.

RESULT OF OPERATIONS FOR VARICOSE VEINS

Jeannel (French Congress of Surgery, 1910) remarks that some surgeons ss as cured cases in which there may be persistence of varicosities if they are s voluminous or less painful and disabling than before operation; other surons only class as cured patients in whom the varices no longer exist and who ive restored to them a healthy, vigorous, painless limb. In the following bles taken from Jeannel the latter conception of the word "cured" is adopted.

A. Results of operations directed against the superficial reflux of blood.

(*a*) Trendelenburg's operation and its variants.

Six hundred and ninety-seven limbs operated on and examined after the apse of from two months to twelve years.

393 cured	56 per cent.	
90 doubtful	13 per cent.	
214 failures	31 per cent.	44 per cent.

(*b*) Resection of whole femoral part of the internal saphenous vein.

Twenty-three limbs operated on and examined after from two months to seven years.

* 12 cured	52 per cent.	
3 doubtful	22 per cent.	
6 failures	26 per cent.	48 per cent.

B. Results of operations directed against the deep reflux of blood.

(*a*) Excision of isolated varices.

Seventy limbs operated on.

* 52 cured	74 per cent.	
3 doubtful	4 per cent.	
15 failures	22 per cent.	26 per cent.

b) Resection of all or most of the internal saphenous or of the external phenous vein.

Fifty-seven limbs operated on and examined after from two months to ght years.

* 26 cured	46 per cent.	
12 doubtful	19 per cent.	
20 failures	35 per cent.	54 per cent.

C. Results of operations directed against both superficial and deep reflux f blood.

(*a*) Trendelenburg's operation with its variants plus multiple ligations and esections both in the thigh and leg.

Ninety-five limbs operated on and examined after from one month to fourteen years.

57 cured	60 per cent.	
21 doubtful	22 per cent.	
17 failures	18 per cent.	40 per cent.

...article in the J. de Chir., Vol.
...peculiar arithmetic.

(*b*) Complete saphenectomy.

Seventy-seven limbs operated on and examined after periods of from a few months to seven years.

73 cured	95 per cent.
4 failures	5 per cent.

These tables of Jeannel's show the importance of recognizing in any individual case whether the trouble is purely due to superficial reflux of blood when Trendelenburg's operation or one of its variants ought to suffice; or whether the trouble is due to a deep reflux of blood or to both superficial and deep reflux when one of the more radical operations will be necessary.

LYMPHANGIOPLASTY (HANDLEY'S OPERATION)

In about 16 per cent. of cases of breast cancer diffusion of the disease and perilymphangitis causes obstruction of the lymphatics about the shoulder which leads to œdema of the arm. This œdema causes intense suffering and disability for which opiates or amputation were the only relief until Handley devised his simple operation.

The operation of lymphangioplasty has *no* effect on the carcinoma; it merely provides new means for the lymphatic drainage of the arm. Handley's results have been most gratifying in relieving suffering, deformity and disability.

Materials required: Several long probes provided with an eye at one end; a supply of No. 12 tubular woven silk.

The Operation.—*Step* 1.—Make a one-inch incision through the skin in the midline of the front of the forearm immediately above the wrist. (Fig. 975, *a*.)

Step 2.—Introduce a probe under the skin through incision *a*. Pass the probe upwards and outwards to the point *b* near the elbow. At this point incise the skin and push the point of the probe out through the incision.

Step 3.—Take a double line of silk more than twice as long as the arm and catch its mid-point with a hemostat. Protect one half of the silk by wrapping it in a towel and thread the other half through the eye of the probe. Pull the probe and with it the silk out through incision *b*. The hemostat attached to the silk prevents too much being pulled out. A double line of silk now lies in the subcutaneous tunnel *a–b* made by the probe.

Step 4.—Reintroduce the probe through the incision *b* and bring it and the silk out through incision *c* made near the insertion of the deltoid.

Step 5.—Pass a second probe through incision *a*, upwards and inwards and make it emerge through incision *d*. The half of the silk line which was wrapped in a towel is now unwrapped and threaded through the eye of the probe. Pull the probe and with it the silk out through incision *d*. Remove the hemostat from the middle of the silk so that the loop of silk becomes buried under the skin at *a*.

Step 6.—In the same fashion pass the silk under the skin from *d* to *c*.

Step 7.—Reintroduce both probes through incision *c* and pass them under the

in round the shoulder to emerge through incision *f* made at the posterior order of the deltoid (Fig. 976).

Step 8.—In the same manner bury a double line of silk under the skin of the ack of the arm along the lines *g h f* and *g k f*. There are now eight threads merging through incision *f*.

Step 9.—Take a long probe, cut off the ends of two of the emerging threads o that they are four inches shorter than the probe and thread them into the ye. Thrust the probe, eye first, through incision *f* and make it penetrate under he skin of the back. The probe being longer than the silk, unthreads itself. Withdraw the probe carefully leaving the two silk threads to occupy its track.

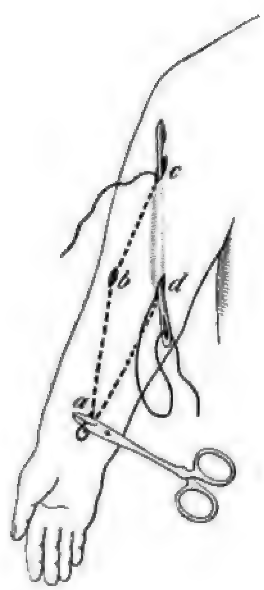


FIG. 975.

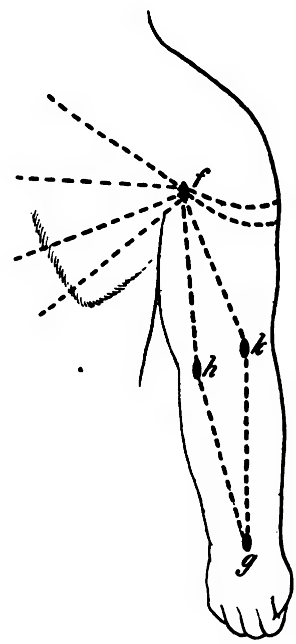


FIG. 976.

FIGS. 975 AND 976.—Lymphangioplasty.

Repeat this manœuvre until all the threads which emerged at *f* have been tucked in various directions into subcutaneous tissues of the back.

Step 10.—Close all the incisions with sutures.

Handley writes ("Brit. Med. Journ.," April 9, 1910).

The choice of cases for lymphangioplasty.

"The analysis of my cases shows that lymphangioplasty is contraindicated i cases where a general anesthetic cannot be borne, and in cases where silk hreads would have to pass through cancerous tissue. It is also inadvisable to perate where there is growth present about the shoulder, if the pain is mainly n axillary one, or is a lancinating pain shooting down the arm. In the presence f pleural effusion or secondary growths the benefits of the operation are trans-

ient, but the shortest period of relief may, under the circumstances, be considered by the patient as worth having.

"Minor degrees of obstruction to the return of lymph from the arm are not infrequently met with in breast cancer. The operation of lymphangioplasty should not be applied indiscriminately, but should be reserved for the severer degrees of lymph-stasis in which other modes of treatment are powerless.

"The axillary scarring which necessarily follows removal of glands may sometimes lead to persistent œdema of the arm, usually slight in amount. In such cases the application of a bandage and the elevation of the arm on an inclined plane for one or two hours a day will usually suffice. In other cases, which ultimately develop into the true brawny arm, the lymph obstruction is partial only. In such cases, although the arm may attain a very considerable size, the œdema is soft and pits freely on pressure. Postural treatment by elevation will sometimes in this stage reduce the size of the arm considerably, and will, to some extent, relieve the pain. The necessity of operation is thus for a time deferred, but the relief obtained is not to be compared with that resulting from lymphangioplasty. It appears, moreover, to be very transient, and in many cases even before the œdema has become solid, postural treatment is intolerable because it severely aggravates the pain. This fact is easily explicable, since the lymph from the forearm, flowing easily upwards into the arm and meeting obstruction there, distends the tissues of the upper arm to an unbearable extent."

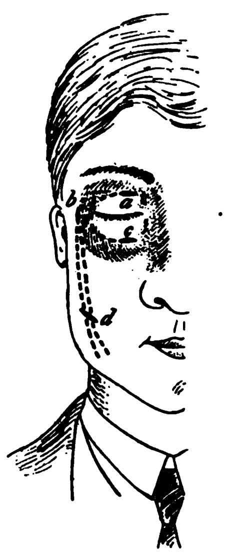


FIG. 977.—Lymphangioplasty.

Elephantiasis.—Handley has applied lymphangioplasty to the treatment of various œdemas of the lower extremity—elephantiasis, Milroy's disease (congential œdema), etc.—but finds that while temporary benefit was obtained the condition always promptly recurred.

W. Clark ("St. Bartholomew's Hosp. Reports," xlv, 1909, Zent., 1910, No. 18) reports a case of œdema of the leg of uncertain origin but of nine years' duration. Implantation of a thread on the inner side from the dorsum of the foot to above the knee gave distinct improvement.

A. B. Mitchell ("B. M. J.," Nov. 20, 1909) reports a case of solid œdema of the eyelids on both sides which followed a severe attack of erysipelas and resisted all ordinary treatment. Handley's operation was performed as follows:

1. Make the very small curved incision *a* (Fig. 977) on the upper eyelid. Through incision *a* pass a probe under the skin to the point *b* at the outer margin of the orbit; expose the point of the probe by incising the skin at *b*. Thread a strand of coarse silk on to the eye of the probe and pull it through the subcutaneous tunnel made by the probe between *a* and *b*.

2. Similarly incise the lower lid at *c* and pass a strand of silk under the skin to emerge at incision *b*.

3. Pass a probe through incision *b* and push it downwards under the skin to the point *d* where a small incision permits the probe to emerge. Thread the two strands of silk emerging at *b* through the eye of the probe and pull them through the subcutaneous tunnel *b d*.

4. With a probe or director introduced through incision *d* made a small pouch under the skin below *d* and into this tuck the ends of the threads.

5. Close all skin wounds.

In Mitchell's case one of the threads caused irritation and had to be removed; the other remained *in situ;* the result was good.

In the case of a young soldier who suffered from solid œdema of the left side of the face and lips due to erysipelas following excision of enlarged cervical glands Mitchell implanted two silk threads the upper ends of which were fastened to the fascia covering the masseter, the lower ends being tucked into the loose tissue behind the clavicle.

"The result was entirely satisfactory; the threads never gave the slightest trouble; the face resumed the natural contour."

Kondoleon ("Zent. für Chir.," No. 30, 1912) finds that in most cases of old elephantiasis from any cause "besides the well-known alterations in the skin and subcutaneous tissues, the fascia is always much thickened (up to 3 cm.), densely infiltrated, immobile, and adherent especially to the fat lying between it and the skin. The outer surface of the fascia is irregular, of a milky hue; the inner surface next the muscles is of normal color and consistence." In a few cases one can separate the fascia from a sheet of connective tissue which lies between it and the subcutaneous fat, in other cases this separation is impossible. Most of the retained lymph lies in the neighborhood of the above-mentioned sheet of connective tissue. Kondoleon finds that if the lymph can gain access to the muscles it is promptly absorbed and he has had apparent good results (though his cases were not observed sufficiently long to permit of definite conclusions) from the following operation:

1. The disease is confined to the leg. On the outer side of the leg make a longitudinal incision through the skin from near the knee to near the ankle. Reflect the skin on each side of the incision until a strip of fat about 4 fingerbreadths wide is exposed. Excise this fat. Excise the thickened deep fascia to an equal extent. Attend to hemostasis. Close the skin wound without drainage. Do the same on the inner side of the leg.

2. The thigh and leg are both involved. After operating on the leg as above described, perform an identical operation on the thigh.

Royster ("Journ. A. M. A.," May 30, 1914) has had good results from the Kondoleon operation.

CHAPTER LXV

OPERATIVE TREATMENT OF SIMPLE FRACTURES, EXCLUSIVE OF THOSE INVOLVING ARTICULATIONS AND OF SOME SPECIAL FRACTURES

Until recently all closed (simple) fractures were treated without operation; to-day most of them are and ought to be exempt from operation. All open (compound) fractures demand operation.

In February, 1911, a committee was appointed by the Council of the British Medical Association "to report on the ultimate results obtained in the treatment of simple fractures with and without operation."

The committee limited its inquiry to simple fractures of the long bones which occurred or in which operations were performed in the period January, 1906, to December, 1910. Every patient reported upon was examined by a member of the committee. The following are the conclusions formulated by the committee:

I. The statistics relative to the non-operative treatment of fractures of the shafts of the long bones in children (under the age of 15 years), with the exception of fractures of both bones of the forearm, show as a rule a high percentage of good results. These are unlikely to be improved upon materially by any other method of treatment. Operative results in children, expressed in percentages, are approximately the same as the non-operative. The relative figures are: Non-operative cases (cases 1017) 90.5 per cent. good functional results. Operative cases (cases 64) 93.6 per cent. good functional results.

II. It is possible either by non-operative or by operative treatment to obtain a high percentage of good results in children.

III. In comparison with the non-operative results in children, the aggregate results of non-operative treatment in those past childhood (*i.e.*, over the age of 15 years) are not satisfactory.

IV. From the analysis of the age groups it is clear that there is a progressive depreciation of the functional result of non-operative treatment as age advances, that is to say, the older the patient the worse the result.

V. In cases treated by immediate operation, the deleterious influence of age upon the functional result is less marked.

VI. In nearly all age groups, operative cases show a higher percentage of good results than non-operative cases.

VII. Although the functional result may be good with an indifferent anatomical result, the most certain way to obtain a good functional result is to secure a good anatomical result.

VIII. No method, whether non-operative or operative, which does not definitely promise a good anatomical result, should be accepted as the method

of choice. For this reason mobilization and massage by themselves have not been found to secure a high percentage of good results. They are, however, valuable supplementary methods of treatment. Similarly, of operative methods, those which secure reposition and absolute fixation of the fragments yield better results than methods which fall short of this; imperfect fixation of the fragments by wire or other suture has been found to be an unsatisfactory procedure in the treatment of fractures of the long bones, with the exception of the olecranon process of the ulna.

IX. Operative treatment should not be regarded as a method to be employed in consequence of the failure of non-operative measures, as the results of secondary operations compare very unfavorably with those of immediate operations. In order to secure the most satisfactory results from operative treatment, it should be resorted to as soon after the accident as practicable.

X. It is necessary to insist that the operative treatment of fractures requires special skill and experience, and such facilities and surroundings as will ensure asepsis. It is, therefore, not a method to be undertaken except by those who have constant practice and experience in such surgical procedures.

XI. A considerable proportion of the failures of operative treatment are due to infection of the wound, a possibility which may occur even with the best technique.

XII. The mortality directly due to the operative treatment of simple fractures of the long bones has been found to be so small that it cannot be urged as a sufficient reason against operative treatment.

XIII. For surgeons and practitioners who are unable to avail themselves of the operative method, the non-operative procedures are likely to remain for some time yet the more safe and serviceable.

(A) **Immediate Operation.**—Immediately after receipt of injury the tissues are freshly lacerated; there is no effusion from irritation; the lymphatics are not clogged with dead material being removed. Unfortunately, from the trauma, much tissue is so injured that its resisting power is lowered and hence an amount of accidental infection, which would be harmless in a wound made during an ordinary operation, might lead to serious consequences. Immediately after injury the conditions are therefore partly favorable and partly unfavorable for operation. Arbuthnot Lane favors early operation.

(B) **Delayed Operation.**—Within a few hours of the receipt of injury the extravasated blood clots in the tissues; coagulable lymph is effused throughout the injured area; the normal lymphatic drains of the part are either overworked or clogged; the bruised but still living tissues have not recovered tone; the whole injured area is in the least favorable condition to withstand any accidental infection. This unfavorable condition persists for about seven days.

(C) **Late Operation.**—During the second week after injury the injured tissues have recovered tone; much of the extravasated blood, etc., has been absorbed; the lymphatic drainage system is in good working order; the ends of the broken bones have gone thorugh the process preparatory to repair. All conditions are favorable for operation. During the period of delay the usual

means of reducing and treating the fracture have been faithfully tried and their failure demonstrates the necessity of operation. Some time during the second week is the period of choice for operation—at a later date, nature's efforts at repair and the occurrence of contractures, etc., would seriously interfere with operative reduction.

PRINCIPLES OF OPERATION

I. **Preparation of Patient.**—If necessary expend several days in cleaning the skin of the part. Scrub repeatedly with soft soap and hot water, using the nail-brush or, better, some form of scrub-cloth. In the interval keep the parts covered with moist dressings or soap poultice. On the evening preceding operation, after thorough scrubbing, apply an antiseptic poultice. On the operating-table repeat the scrubbing and sterilize the skin by rubbing into it Harrington's solution or some other reliable antiseptic.

FIG. 978.—Lane's forceps or tongs.

II. Make an appropriate incision where it will do least harm and give the most free possible access. Make the incision too long rather than too short. As soon as the skin is completely divided exclude it from the rest of the wound by sterile cloths held in place by a few stitches or by volsella forceps. Complete the exposure of the fracture by blunt and sharp dissection.

Never touch the wound with the bare hand; make all necessary manipulations with instruments (König's rule) or wear rubber gloves. Do not let such parts

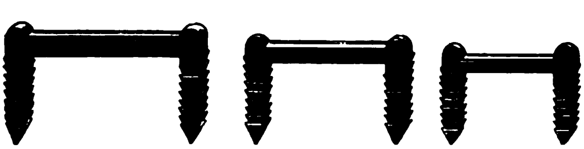


FIG. 979.—Jacoel's staples.

FIG. 980.—Int. splint.

of instruments as have touched the skin of the patient or the bare hand of the surgeon enter the wound. Lane, in fact, does not permit even the *gloved* hand to enter the wound.

III. Having thoroughly exposed the ends of the bone, remove all blood-clot and material intervening between them. Fritz König advises against a too thorough removal of *all* material between the fractured surfaces, as nature will attend to this and much of the material here present is of value in the formation of callus; it is only necessary to remove such structures as will probably interfere with union. König writes ("Archiv für klin. Chir.," lxxvi, 725): "except in resections (when union has been despaired of) or when there is ab-

normal effusion into involved joints, we do not concern ourselves much with blood-clots."

Lane, however, thinks that bones ought to unite with practically no callus.

Now attend to hemostasis and bring the fragments into apposition by means of traction combined with the leverage action of powerful long-handled forceps. Lane's forceps are shown in Fig. 978. They are so constructed as to grasp the bones firmly and yet not exert injurious pressure. Different sizes of forceps are required for large bones, as the femur, and small bones, like the ulna. The forceps hold the fragments in place admirably while screw nails, staples,

FIG. 981.—(*Gerster, Annals of Surgery.*)

or metal splints are being applied. Lowman's bone and plate holder (Fig. 994) is also a useful aid. John Gerster's turnbuckles (Fig. 981) applied to Lowman's clamps are of service in obtaining and maintaining reduction. If the fragments tend to remain in apposition, close the wound with or without drainage and treat as a simple fracture. If there is any doubt as to the maintenance of apposition it is necessary to insure it by means of sutures (wire or chromic gut), pegs, screw nails (Lane), ordinary wire nails, intramedullary bone plates or tubes,* staples (Jacoël) (Fig. 979), buried steel splints (Fig. 980), Freeman's apparatus, etc.,

* Carleton Flint used pegs made from fresh ox bone. These pegs, at first square in section, are roughly rounded with a file and sterilized by boiling.

FIG. 982.—(*Lane.*)

FIG. 983.—(*Lane.*)

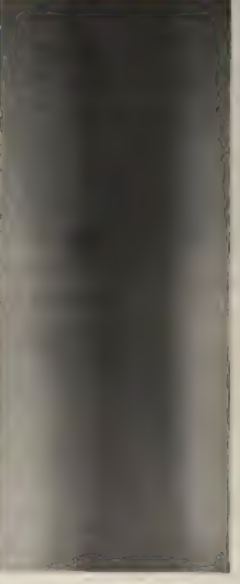


FIG. 984.—(*Lane.*)

FIG. 985.—(*Lane.*)

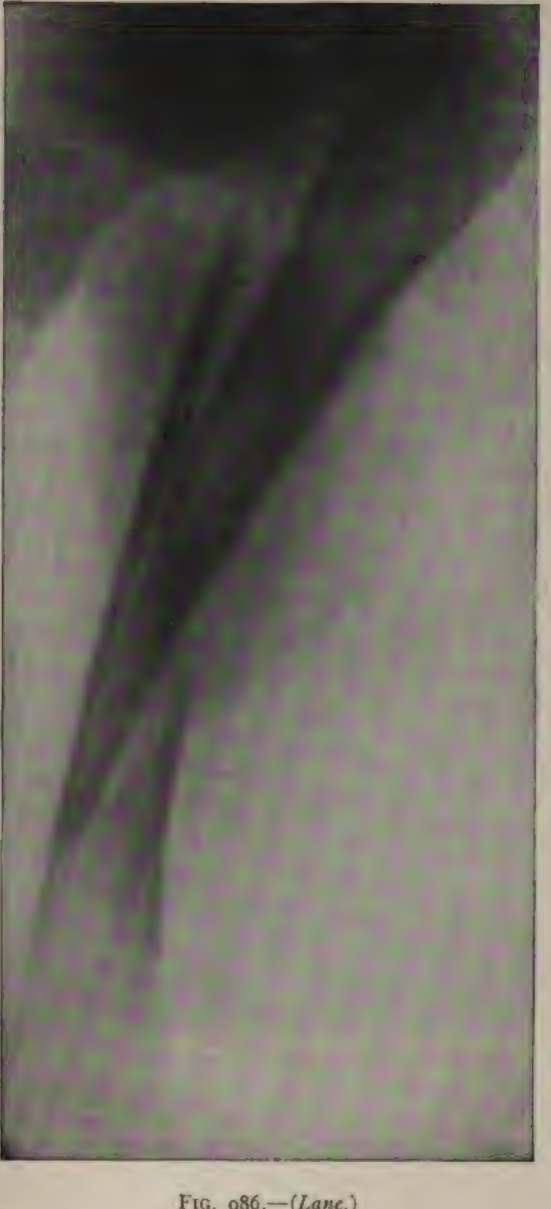


FIG. 986.—(*Lane.*)

FIG. 987.—(*Lane.*)

FIG. 988 A.—(*Lane.*)

FIG. 988 B.—(*Lane.*)

FIG. 989.—(*Lane.*)

FIG. 990.—(*Lane.*)

etc. (see p. 903). When steel plates are used see that they are strong. Sherman used plates of vanadium spring steel with screws of the same metal, Fig. 992.

IV. Close the wound with or preferably without drainage. Dress. Immobilize.

FIG. 991.—(*Lane.*)

FIG 992.—Sherman's vanadium steel bone plates.

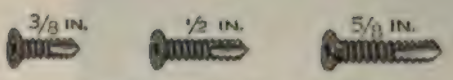


FIG. 993.—Sherman vanadium steel tap screws.

FIG. 994.—Lowman's bone and plate holder.

Figures 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, kindly put at the author's disposal by Sir Arbuthnot Lane, explain better than words the uses of buried metal splints.

CHAPTER LXVI

COMPOUND OR OPEN FRACTURES

Practically every fracture communicating with the open air through a wound, no matter how trivial the wound may appear, ought to be subjected to operation. The object of the operation is the treatment of the deep wound; treatment of the fracture is a secondary consideration and may be carried out either at this time or later, as may seem best. The method of treatment varies according to the severity of the injury, the amount of dirt ingrained into the wound, and the conditions surrounding the patient. An elaborate method of operating with fixation of the fractured bones is very proper when a good operating-room and good assistance are available and yet may be quite improper under less favorable circumstances.

Example.—Compound fracture middle of humerus; small wound through skin; much laceration muscles. Unfavorable surroundings. Treatment adopted: Free enlargement skin wound; loose packing with gauze; immobilization in *comfortable* position, but no attempt at exact reposition of bones. Removal of pack in about 48 hours. Application of dressings and immobilization as before. Reduction of fracture on eighth day. Careful immobilization. If it had been easy to reduce the fracture and keep it reduced during the days when the wound required attention, immediate reduction would have been effected, but as it was the patient was comfortable, the wound healed well, and no time was lost.

When it is evident that injury to the vessels, etc., of the part has destroyed all hope of maintaining the nutrition of the parts distal to the fracture, amputation must be done; under other circumstances conservative operation is imperative.

An operation for open fracture of the tibia may be taken as typical.

OPERATION FOR OPEN FRACTURE OF THE TIBIA

Step 1.—Anesthetize. Scrub the *whole* leg with soap and hot water, using a wash cloth. Shave the leg. Scrub the whole leg with turpentine, gasoline, or ether to remove grease. Scrub once more with soap and water. Scrub with alcohol. Scrub with some reliable antiseptic solution, preferably Harrington's solution (commercial alcohol (94 per cent.), 640 c.c.; hydrochloric acid, 60 c.c.; water 300 c.c.; corrosive sublimate, 0.8 gram). Instead of the above elaborate classical preparation one may use Grossich's plan, viz., avoid the use of water, shave off the hair (dry), paint with tincture of iodine. Apply an elastic constrictor.

Step 2.—Enlarge the skin wound freely so that every nook and cranny of the deep wound becomes accessible. With gauze sponges, gloved finger, and instruments remove all foreign material, blood-clots, etc. Dissect away the ragged skin around the wound, also all portions of tissue so injured that they cannot live. Remove completely all detached fragments of bone. These fragments Macewen scrubs thoroughly, lays aside in a warm aseptic solution and reimplants with good effect, when necessary. Too few surgeons follow Macewen's lead in this.

Fragments of bone still attached to the shaft by periosteum may be cleansed and retained. Remove all tissues which will interfere with union by becoming interposed between the fractured surfaces. With retractors open all torn tissue planes and spaces; clean such thoroughly with douche and mop. If much dirt has gained access, mop out the whole wound with pure liquid carbolic acid and immediately follow this by mopping with alcohol to dilute and remove the acid. Instead of carbolic acid and alcohol, Harrington's solution may be used. Provide free drainage for every part of the wound through counter-punctures when necessary. Reduce the fracture. If necessary for fixation, unite the fractured surfaces by sutures of wire or catgut or by means of the pegs, etc., described elsewhere. The objection to the use of wire, pegs, nails, etc., is the irritation which they are likely to keep up if the wound is or becomes infected. In an open fracture of the femur, where asepsis was evidently unattainable, C. H. Mayo mortised the bones together (Fig. 995) so that fixation was obtained without employing any foreign body. Remove the elastic constrictor. Attend to hemostasis by means of forceps, ligatures, and hot water. See that the drainage-tubes are in place and not clogged.

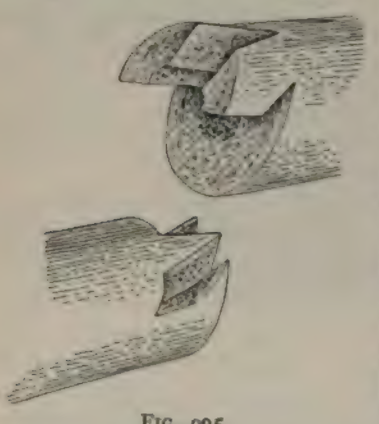


FIG. 995.

Step 3.—Partially close the external wound. Dress. Immobilize. (Hodgen's splint is excellent.)

J. Hogarth Pringle (Brit. Journ. Surg., II, No. 5) enunciates the following rules which he follows in the treatment of open fractures of the long bones. Large fragments of bone ought always to be saved whether they have or have not been deprived of periosteum. They are preserved in warm salt solution until required, and if soiled, the infected surfaces are removed with a chisel. The preservation of such fragments is of special value if they represent the "third fragment" of a flexion or spiral fracture because if they are not implanted, two pointed and often narrow ends of bone are left, a pseudarthrosis may result, or, if union takes place, there is much shortening. Always use fixation by means of wire, screws, nails, plates, etc. Always excise the original skin wound. When confident of asepsis always try to close the wound even if relaxation in-

cisions are required. These incisions should always be made if there is much undermining of the skin from violence.

Unless very confident of asepsis leave the wound open. This means delay, but without harm provided the exposed bone and fascia are kept moist. If the wound is open the fixing agents (plates, etc.) are left until consolidation is secure and are then removed.

Lilienthal (Trans. Am. Surg. Assoc., 1912) fixes the bone by means of Lane's plates, but instead of the ordinary screws he uses screws with the head prolonged into a steel shaft 3 to 5 inches long with a square pyramidal head to fit a key which is to be used instead of a screw-driver. To simplify extraction of the plate he threads a strand of silver-plated piano wire into the terminal apertures of the plate and lets this wire protrude from the wound with the elongated screw shanks.

This method being used in infected fractures, the wound is packed. The screws and plates are easily removed when no longer required.

In very complicated cases the author has often left the wound wide open, filling it loosely with gauze; if after a few days it is evident that asepsis has been attained the wound may be closed in whole or in part; if asepsis has not been attained the openness of the wound is a great element of safety. Always remember that treatment of the wound is of incomparably greater importance than reduction of the fracture. If reduction of the fracture does not interfere with drainage and wound treatment, then immediate reduction is indicated; if reduction interferes in any way with efficient drainage, then partial reduction *plus* as thorough as possible immobilization is the treatment of choice until the drains are removed when reduction should be carried out. During the after-treatment some form of interrupted splint is a great boon, as it permits the dressings to be changed with the least possible disturbance of the parts.

An open fracture at the articular end of a bone may involve the joint in one or two ways: (*a*) A split or fissure may extend from the main site of fracture and the external wound into the joint. If such a fracture is seen early it is very improbable that infection will have reached the joint unless the fissure or split is short, *i.e.*, unless the distance from the point of articular involvement to the external wound is short. Under the above favorable conditions, treat the case as a compound fracture without articular involvement.

(*b*) There is free communication between the external wound and the joint. Treat the fracture *secundum artem;* treat the joint by arthrotomy, *i.e.*, provide free drainage as if arthritis had already developed. The treatment of the consequences of articular infection will be considered elsewhere.

CHAPTER LXVII

UNUNITED FRACTURE. PSEUDARTHROSIS

The local causes of non-union of fractures are usually (*a*) separation of the fragments, (*b*) insufficient or improper immobilization, and (*c*) most important of all, interposition of muscle, fascia, or fat between the fragments. The principles of operative treatment consist in (*a*) removal of interposed tissue; (*b*) freshening of the ends of the bones; (*c*) obtaining and maintaining apposition of the fragments. If these principles are carried out with cleanliness, union is sure, provided that the local and general vitality, *i.e.*, the recuperative power, is sufficient.

Often long-continued non-union results in contracture or shortening of the soft parts and this, unless corrected, may prevent either the obtaining or maintaining of apposition of the fragments. Where moderate contracture is present Treves very wisely recommends that extension be applied to the limb for a week or more prior to operation. Edward Martin, in the case of an ununited fracture of the femur with 2½ inches of shortening, having failed to attain results by the usual means of traction, devised the following method: "It consists in a long, strong canvas strip pocketed in the middle and looped at the ends. The bones at the seat of fracture are freed, the pocket is slipped over the proximal end of the distal fragment, the ends of the canvas strip are carried in the long axis of the limb and in the loops is fixed a cord to which are attached the weights. By thumb pressure the bone is kept from angling out of the wound, and weights up to 100 pounds, or more, are attached to the rope. In from three to five minutes the shortening is overcome. Only those structures which interfere with proper placement are stretched, and this is done so thoroughly that there is but slight tendency to the reproduction of deformity" ("Surg., Gyn., Obst.," Jan., 1910).

Ochsner prefers gradual extension; he says "the only thing that is peculiar about the method is the application of rubber adhesive strips to as high a point above the seat of fracture as is possible."

For instance, instead of applying the rubber adhesive up to the fracture, it should be applied over the entire length of the thigh, then, with no more than 24 pounds of weight, we have, in every fracture where there has not been a union, been able to stretch the muscles sufficiently to replace the fractures without making a resection of the ends. In cases where there is a union in malposition, the muscles will stretch to a marked extent. Extension may be supplemented in some cases by preliminary division of the contracted tissues, although such division is more commonly done at the time of the major operation. The *aim* of the surgeon must be to so operate that whatever means of fixation

used, its function may be
ents of bone ought to be so

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route to the site of fracture
ust damage to the tissues. Re-
(e.g., the musculo-spiral nerve in
possible penetrate to the bone be-
Usually a longitudinal incision,

nal, though it is preferable to avoid
elected make a vertical cut through

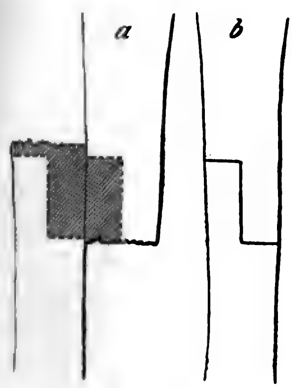


FIG. 997.

h the deep fascia. To find an intermuscular
flect the skin from the fascia for a short distance
sion. Divide the fascia over an intermuscular
p and blunt dissection penetrate the septum to
ose the bone. The length of the wound must be
the site of fracture. A small incision inevitably
mage to the tissues during the rest of the operation.
or rugine separate enough of the periosteum (if
attached muscles) to permit of a thorough appre-
be dealt with. [Amount of fibrous tissue between
paration; amount of bone atrophy; obliquity of the
.]
e fascia by a vertical incision one may reflect the skin
U-, or ∩-shaped incision. After the fascia is exposed
is as described above.
on of the Ends of the Bone for Their Union.—The
ds of the bone depends on the conditions found at the

site of fracture. The bones may be united by fibrous tissue, their ends may be conical from atrophy, there may be a wide separation between them or one fragment may have overridden the other, causing much shortening. The line of fracture may be transverse, oblique, or irregular. (*a*) Dissect all foreign material (fibrous tissue, muscle, etc.) from between the bones. (*b*) If possible, make each fragment of bone in turn protrude from the wound

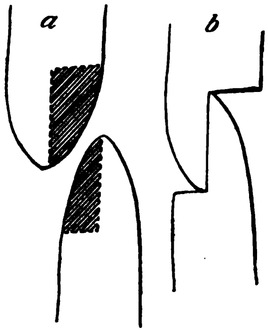


FIG. 998.

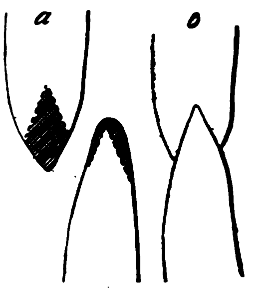


FIG. 999.

and vivify it by sawing off thin slices of the bone until a healthy bleeding surface is obtained. (*c*) If it is impossible to make the ends of the bone protrude, vivify them *in situ* by means of a finger or a Gigli wire saw or a chisel.

As a rule, an oblique fracture can be best vivified with a chisel; a transverse fracture or one where the ends have become conical, with a saw. (*d*) When vivifying the ends of the bone it is often possible to so shape them that the one fragment will mortise into the other and thus tend to remain in position. A

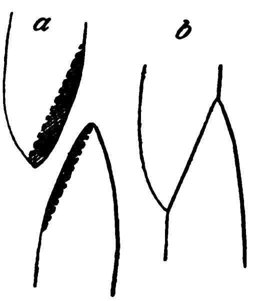


FIG. 1000.

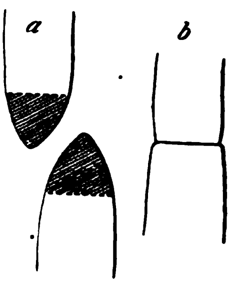


FIG. 1001.

chisel or gauge is the best instrument with which to shape the ends of the bone. Figures 996, 997, 998, 999, 1000, 1001 show various methods of vivifying and modeling the ends of the bones.

A. G. Wildey (Brit. J. Surg., II, No. 7, p. 423) operates on ununited fractures as follows: Freely expose the site of fracture. Bring the ends of the bone out into the wound. Vivify their terminal surfaces by removing a very thin slice

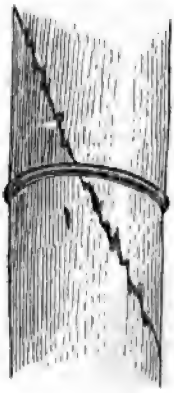


FIG. 1002.

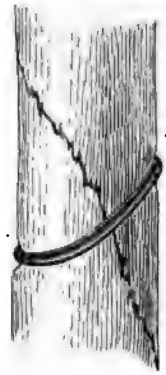


FIG. 1003.

FIG. 1002.—Improper application of wire.
FIG. 1003.—Proper application of wire. Note the wire is at right angles to the of fracture.

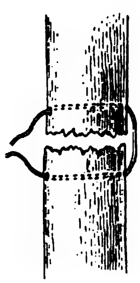


FIG. 1004.

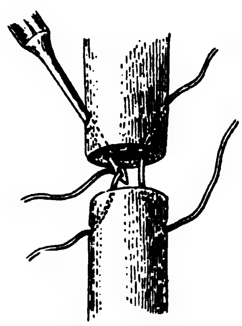


FIG. 1005.

FIG. 1006.

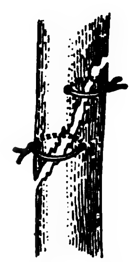


FIG. 1007.

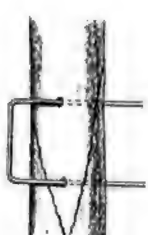


FIG. 1008.

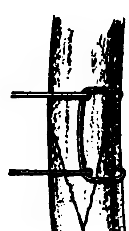


FIG. 1009.

FIG. 1010.

FIGS. 1008, 1009 AND 1010.—(*Monod and Vanvert.*)

from each. Remove the plugs of callus or fibrous tissue from each end by a gouge or drill. Drill the circle of indurated bone in four or five places *parallel to the long axis of the bone*, using drills Nos. 1 to 3. The drills must penetrate to normal bone which is shown by lessened resistance to the advance of the drill and by bleeding. Usually a depth of from 1 to 2 inches is necessary to open a vascular area of bone. The deeper the perforation required, the larger should be the drill and the more numerous the holes bored. When both fragments have

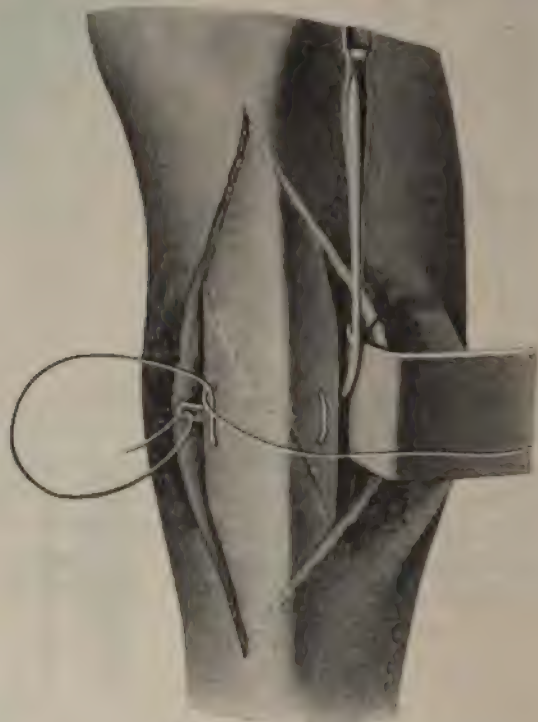


FIG. 1011.—(*Lejars.*)

been treated, place them in apposition and secure fixation by means of Lane's plates. Wildey finds that union is easily secured, is very firm, but that there is some excess of callus.

Step 3.—**Union of the Bones.**—If the fragments show a marked tendency to remain in apposition, the wound may be closed and the case treated by splints, etc., like any ordinary fracture. Unfortunately, the above is not commonly sufficient and it becomes necessary to hold the bones together by some means applied directly to them. The methods devised for attaining direct union of the fragments are legion—a few of the principal ones will be given here.

Method A.—Suture of Wire or Catgut.—Figures 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1009, 1010, 1011, 1012 show how transverse or oblique fractures may be fastened together with stout wire or stout chromicized catgut. If wire is used, the ends, after twisting, must be cut off short and any sharp pro-

truding ends must be hammered flat or directed into the bone so as not to lacerate the soft parts. Most surgeons use silver or aluminum-bronze wire.

Method B.—Fixation by Nails or Bone Pegs.—Where the fractured surfaces are oblique, bore a hole transversely through both fragments—temporarily leave the drill *in situ*. With a second drill bore another hole through both fragments; remove this drill and replace it by a bone peg. Remove the drill first introduced and replace it also by a bone peg. The drill left *in situ* keeps

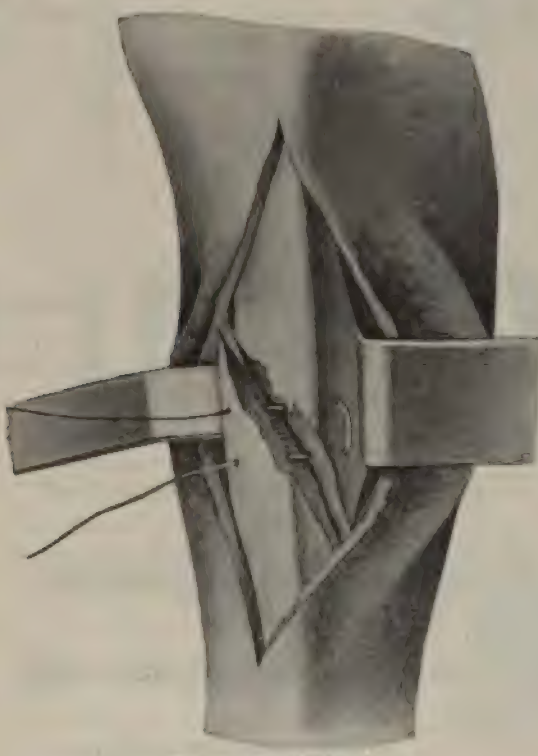


FIG. 1012.—(*Lejars.*)

the fragments in good position while the first peg is being introduced. Bone pegs are easily made from a bone knitting needle of convenient thickness and are sterilized by being boiled. When the pegs have been driven into position, any part which may protrude must be cut off flush with the bone. Instead of bone pegs metal nails or screws may be used in the same way.

Figures 1013 and 1014 show the application of pegs. Jacoël and Dujarier have devised useful metal staples to take the place of nails or screws (Fig. 1015).

Depage (Fig. 1016) provides a long screw which terminates in a pliable wire. After boring a suitable hole he passes the screw through both fragments. Guided by the pliable wire he threads a nut on to the screw and thus can get very firm approximation. The excess of screw is cut away. The objections

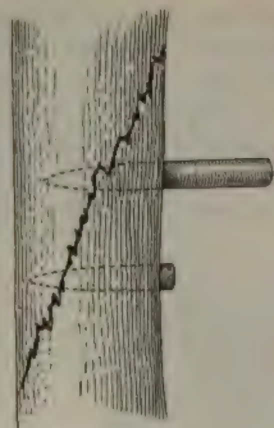


FIG. 1013.

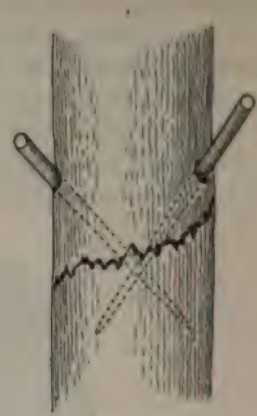


FIG. 1014.

FIG. 1015.—Jacoël's staples.

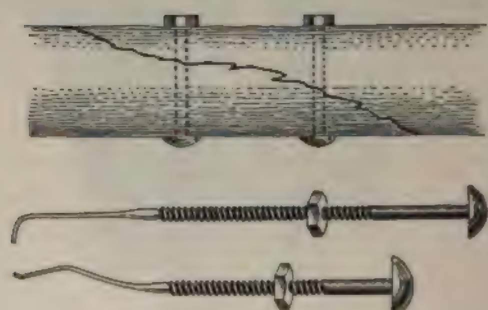


FIG. 1016.—Depage's screw's.

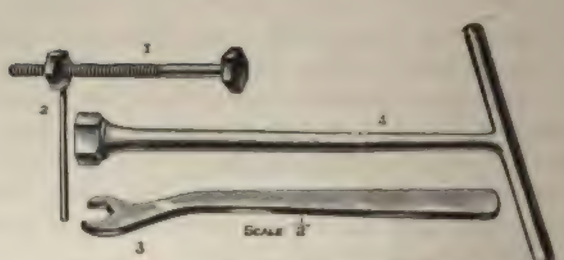


FIG. 1017.—(*Cuthbert-Wallace, The Lancet.*)

Showing the essential parts: 1. A bolt. 2. A nut with a soft wire brazed to one facet. 3. A flat spanner. 4. A clock-key spanner.

to this procedure are the wide exposure necessary and the difficulty of removing the plate should that subsequently be necessary.

Cuthbert-Wallace (Lancet, May 15, 1915), to avoid extensive exposure of the bones in oblique fractures, uses a very simple bolt as follows: Expose the bone. Reduce the fracture. Drill a hole through the central point of the fracture. If the fracture is *not* very oblique the hole should be bored more or less at right angles to the line of fracture, otherwise it should be at right angles to the axis of the bone. The hole ought to be a little larger than the bolt. Push the bolt through the hole till its end just emerges on the opposite side. Holding the nut (Fig. 1017) by the wire attached to it, place it in position on the bolt and screw the bolt home with the clock-key spanner. Traction on the wire prevents the nut turning with the bolt. When fixation is accomplished cut off the end of the bolt protruding from the nut with strong pliers. Bend the wire around the bone to the head of the bolt. Cut off the excess of wire. The wire left *in situ* renders removal of the bolt easy if this is necessary at any time. If the bolt is introduced obliquely to the axis of the bone shaft its head can easily be housed by cutting a small hollow in the bone.

Method C.—Fixation by Drills or Long Metal Nails.—This method is the same as B, except that the drills used to perforate the bone are left *in situ* with their proximal ends protruding through the wound in the soft parts. After two or three weeks the drills become loose and are easily removed. Both methods B and C have given the author much satisfaction.

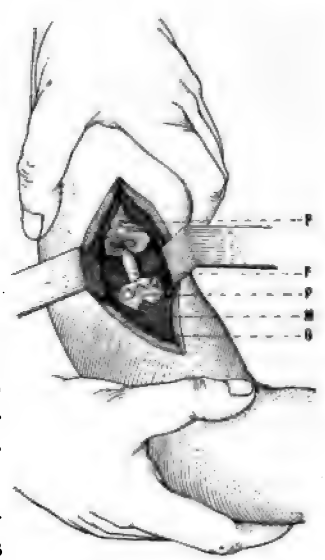


FIG. 1018.—(*Lejars.*)
P, Upper fragment; P', Lower fragment; F, Peg; M, Muscle; G, Fat.

Method D.—Fixation of Intra-medullary Pegs.—Prepare beforehand several bone or ivory pegs of different sizes so as to be sure to have one about the calibre of the central cavity of the bone. Bend the limb so that the end of the lower fragment of bone is easily accessible; lightly drive a prepared peg into the medullary cavity for a distance of 1 to 1½ inches. Manipulate the limb so that the end of the peg protruding from the lower fragment enters the medullary canal of the upper fragment (Fig. 1018).

Murphy uses a transplant from the same patient as an intramedullary peg. The tibia is usually the source of supply. After vivifying the ends of the bone to be united, enlarge the marrow cavity of both the upper and lower fragments with a reamer or burr for a distance sufficient to form a good firm bed for the implant. Thorough reaming is an insurance against fat embolism. Pack the wound and protect it thoroughly. Make a longitudinal incision over and through the tibialis anticus and divide the underlying periosteum of the tibia near the crest. Retract the edges of the wound. Separate the periosteum from

the crest of the bone. (The object in making the incision through the muscle is to have a good covering for the defect which will be left in the bone.)

Mark the upper and lower limits of the desired transplant by boring holes in the bone. With a saw make a transverse cut in the bone at each end of the part to be transplanted. The transplant must usually be as thick as the surgeon's little finger or even fore-finger, and the transverse cuts must therefore be about ½ or ¾ inch deep. With a chisel cut a groove along the bone from the bottom of one transverse cut to the bottom of the other. This prevents splintering of the fragment. Apply a broad chisel or osteotome to the groove, cut through the bone and remove the fragment. Place the fragment in warm salt solution or moist gauze. Close the wound with deep and superficial sutures.

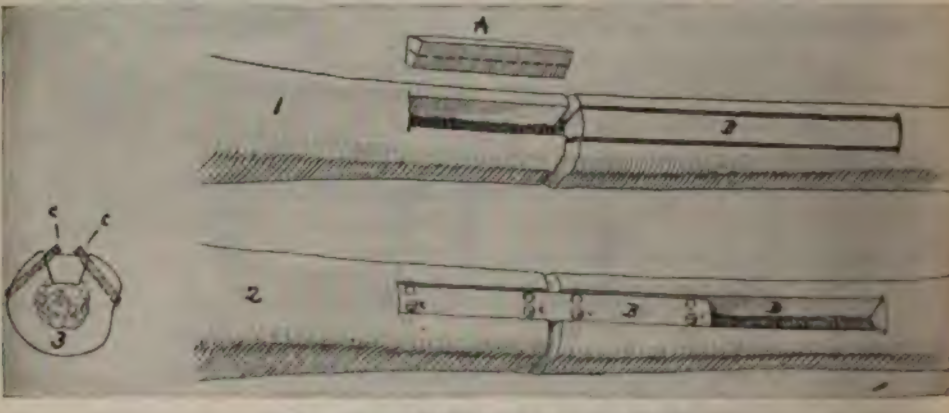


FIG. 1019.—(*Albee, Surg., Gyn. and Obst.*)

1. *A*, short segment bone cut out from above fracture by double circular saw; *B*, long segment bone from below fracture. 2. Segment bone *B* put partly in gutter from which *A* was excised and partly in its own gutter, crosses the site of fracture and acts as splint. 3. Section of splint in place and held firmly by pegs made out of segment *A*.

Remove the pack from the wound exposing the bones to be united. Use the fragment of bone exactly as if it were an ivory or bone peg. It is of prime importance to have absolute contact maintained between the implant and its upper and lower bed, viz., the cavities prepared in the bones to be united. For this purpose it may be necessary to drill transversely through the receiving bone and the implant and insert a nail.

Even if apposition between the fragments of the fractured bone is impossible, the implant will live if asepsis is maintained and if its ends are kept in contact with the vivified bone above and below. Union cannot be firm in less than from forty to sixty days.

Albee (Surg., Gyn. and Obst., June, 1914) uses, in recent fractures, an autogenous graft or implant obtained from the fractured bone. Figure 1019 sufficiently describes his method. In cases of pseudarthrosis the bone near the site of fracture is usually eburnated, and it is better under these circumstances to obtain the graft from some other bone, usually the tibia, of the patient himself.

Magnuson (Journ. A. M. A., Oct. 25, 1913) attains fixation in transverse fractures by means of absorbable ivory plates. The plates measure 2 inches in

inch deep, $\frac{1}{8}$ inch thick. (A larger plate, $2\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$ inches, ade.) With a circular saw having two parallel blades at proper distance cut a slot exactly the width of the ivory plates make two longitudinal incisions in the long axis of the bone and across the fracture. These the same length as the ivory plate and penetrate to the marrow cavity. iole at each end of the parallel cuts so as to mobilize the contained bone nit its extraction. The result is a slot into which the ivory plate is now At right angles to the plane of the plate drill a hole on each side of the and drive into these holes ivory pegs or nails. Close the wound and a simple fracture.

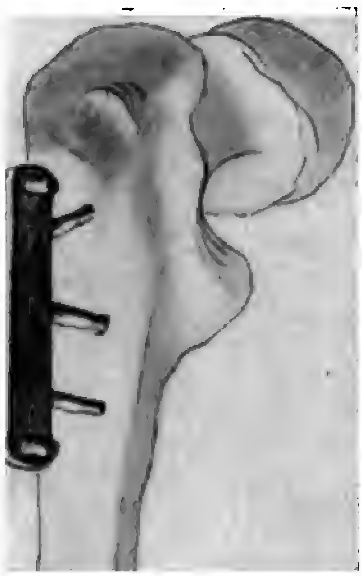


FIG. 1020.—(*Freeman.*)

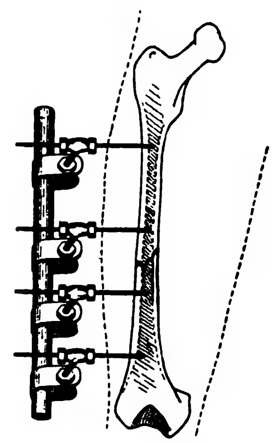


FIG. 1021.—(*Lambotte.*)

iod E.—Fixation by Means of "Fish Plates." Internal Splinting. est plates are those of Arbuthnot Lane made of stout steel. Such may ned in various sizes. W. O. Sherman finds plates of Vanadium spring onger and less bulky than Lane's plates. The screws are of metal and e a trifle over $\frac{1}{2}$ inch in length. Figures 985 and 987 show clearly the ion of "fish plates" to a bone.

iod F.—Fixation by Means of Long Screws and External Clamps.— thod has been recommended by Keetley, Parkhill and Freeman. The ion of Parkhill's most ingenious apparatus is difficult because of its ity.

man, by using strips of hard wood backed by steel plates (Fig. 1020) lered the method exceedingly simple. The attached figures sufficiently the procedure. Figures 1021 and 1022 show an exceedingly complicated us on the same principles which has given Lambotte excellent results.

Lilienthal's Modification of the Parkhill-Freeman Device.—The apparatus may be used in closed or open fractures, the latter will alone be described here.

Provide four gimlets of the square-headed variety which fit in a brace or can be put in with a key; provide two rods of steel about the size of small telegraph wire. Near the fracture, bore one gimlet into the bone at right angles to the shaft, deeply enough so that there will be no play on gentle attempts at motion. Introduce a second gimlet an inch or two above the first. In the same manner introduce two gimlets into the other fragment. Reduce the fracture and

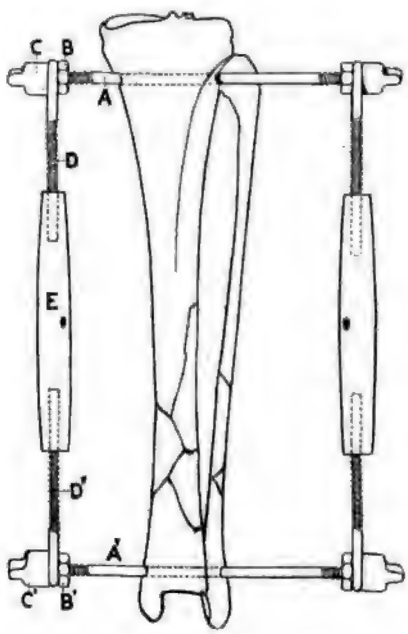
Fig. 1022.—(*Lambotte.*)

hold the bones in place either by external manipulation or by bone clamps. The gimlets protruding from the wound are not in alignment. Apply the steel rods "in such a way along the line of gimlets and roughly parallel to the bone that the rods and gimlets shall be in contact. If the gimlets were in a perfectly straight line one rod would be sufficient, for it would touch all of them; but the line being a staggering one, two rods will be found necessary." The steel rods should be near the heads of the gimlets, *i.e.*, remote from the wound. Bandage

the rods and gimlets together with a plaster-of-Paris bandage sterilized by baking. Disinfect the wound again and loosely pack with gauze. Apply a light rigid dressing.

Hey-Groves' method ("Lancet," Feb. 21, 1914) combines distraction with fixation. It is suitable only in fractures of the leg.

"Transfix both tibia and fibula with pin A′ one inch above the tip of the internal malleolus. Apply strong traction to the leg and reduce the fracture as accurately as possible. Transfix the tibia with pin A opposite the tubercle.



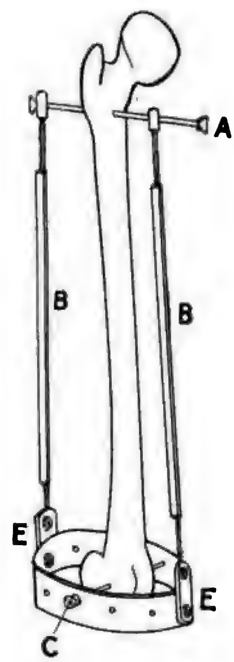


FIG. 1023. FIG. 1024.

FIG. 1023.—Hey-Groves' double transfixion apparatus for complicated fractures of the leg bones. *A,A′* = highly tempered steel bars which transfix the tibia above and both bones below. They are sufficiently long to act as springs when their ends are pushed apart. One end of each is a drill point and the other is slotted to fit a drill handle, so that each is used to bore its own hole. *B,B′* = nuts screwed on to *A,A′* after insertion. *C,C′* = screw caps which protect the ends of *A,A′* and fix the apparatus rigidly when a correct position has been attained. *D,D′* = rods with eyes which slip over *A,A′* and opposite screw threads which fit into cylinder *E*.

FIG. 1024.—Hey-Groves' improved apparatus for extension and fixation.

A. Pin transfixing upper end of bone. *B*. Lateral rods which can be elongated as in fig. 1023. *C*. Pin transfixing lower end of bone; this need not be parallel to pin *A*. *D*. Perforated iron band to surround the limb. Pin *C* passes through holes in this band. *E*. Clips fixing lateral rods to any part of the band *D* and permitting lateral movement through 30°.

"The two pins must enter the bone by exactly parallel routes. To the pins affix the rest of the apparatus, Fig. 1023. By rotating the cylinders E distraction is obtained. After a few days the patient can leave his bed and walk with crutches, and at the end of ten days he can put his foot to the ground and gradually bear his weight upon his injured leg. The apparatus is removed in three weeks in the comminuted cases when union is rapid, but it may be left on for six weeks in a case where union is slow."

Exact parallelism of the two pins is different to attain, therefore Hey-Groves has modified his apparatus, as follows: "The apparatus consists in two transfixion pins $\frac{3}{16}$ inch thick, and two longitudinal extension bars made of a tube into which screw rods $\frac{1}{4}$ inch thick threaded with reversed screws (Fig. 1024). The tube is perforated at its centre by holes for a lever, and when it is turned in one direction both the projecting bars are forced apart, whilst the reverse movement draws them together. One of the transfixion pins passes through two holes in a circular hoop of steel 6 inches in diameter $\frac{1}{8}$ inch thick and 1 inch wide. There are twelve holes in the hoop, arranged as six opposite pairs, so that the pin can lie in any one of six different diameters of the hoop. The extension bars fit by an eyelet-hole over the ends of one pin, and by the other they take a bearing on the steel hoop by a joint which allows of a lateral movement through 30°. This point can be locked. When the apparatus is in position it permits of the following movements:

"1. Direct Extension, by rotating the central tubes of the longitudinal bars in the same direction.

"2. Tilting of the transfixion pins with consequent correction of angular deformity, by screwing one extension bar more than the other, or by screwing them in reverse directions. If the one pin which pierces the hoop lies at right angles to the plane of the extension bars, it can be tilted by pulling on one end in a distal and the other in a proximal direction.

"3. Rotation of one transfixion pin in relation to the other. This allows of rotatory displacement being corrected.

"As regards the technique of the application of this apparatus to the thigh or lower leg, the general remarks made about transfixion apply here, but in the making of the punctures for the upper or counter extension pin, the skin must be drawn downwards, whereas with the lower it is drawn upwards for the avoidance of tension.

"In applying the upper pin to the femur a point is taken on the front of the thigh vertically below the anterior superior iliac spine and on a level with the lower border of the symphysis pubis. This is over the base of the great trochanter. The pin is inserted backwards, so that its posterior end emerges behind the prominence of the trochanter and not at the back of the thigh.

"The upper pin in the tibia should lie between the level of the lower border of the patella and the tuberosity of the tibia, in a transverse direction. In each case the lower pin is in the position described above for simple transfixion.

"The apparatus is applied under general anesthesia; the double transfixion, only occupying about $2\frac{1}{2}$ minutes, can be done under gas, but unless there is any contraindication ether is better, because this gives a fuller muscular relaxation and affords time for the adjustment of the hoop and extension bars.

"Before the operation it is known by measurement or better by the X-rays exactly how much shortening exists. The longitudinal bars are twisted in their central tubular portions until this is fully corrected or until the transfixion pins show a marked bowing. Being made of higher tempered steel, they act as powerful springs, and within two days they will have straight-

ned themselves, and further extension can be given by a few turns of the ibular screws, and so on at two-day intervals until the correct length of the one has been gained.

"The limb is slung up off the bed, so that the wounds can be dressed with e least disturbance. At the end of a week the patient with a fracture of e tibia and fibula can get up and the one with the fractured femur can be oved."

Method G.—Fixation by Ferrules of Decalcified Bone. (Senn.)—Figure 025 sufficiently shows this method.

Step 4.—**Closure of the Wound.**—Have an assistant hold the limb steady a good position. Close the periosteal wound with fine catgut sutures. Close he rest of the wound *secundum artem,* with or without drainage. Apply dressngs. Immobilize by plaster of Paris or splints. Treat as an ordinary fracture.

Early in this chapter it was stated that if the principles of treatment here outlined are carried out with cleanliness union is sure, *provided that the local and general vitality, i.e., the recuperative power, is sufficient.* Where the general vitality is low it must be stimulated by proper diet, tonics, and especially by the open air. Where the local vitality is low, although the wound may heal by primary union, yet the fracture may not consolidate, the bone-forming cells have not done their work. To stimulate repair, massage is of value and the use of apparatus which permits of ambulatory treatment may also aid.

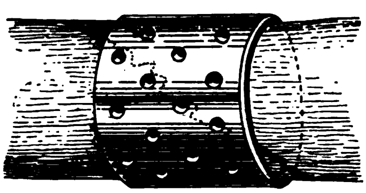


FIG. 1025.—Decalcified bone ferrule in place.

v. Büngner ("Archiv für klin. Chir.," xli, 185) recommends that primary union be *not* sought in cases where atrophy of the fractured ends of the bone is present, but that after these structures are fixed together by any of the methods described, the wound be packed with gauze and allowed to heal by granulation. There is much to be said in favor of this suggestion.

When one bone of the leg or forearm is the site of pseudarthrosis and there much loss of substance, this loss must either be made good or apposition of le fragments obtained by excising a portion of, and so proportionately shorting the companion bone. For example, after freshening the ends of the bone pseudarthrosis of the tibia, direct apposition may be impossible until a segent of the fibula is excised. Where the fracture is situated in the lower third the radius it is better to excise a portion of the distal end of the ulna rather an a segment of that bone opposite the radial fracture. By doing this the ecessity of obtaining bony union of a new fracture is avoided. Such methods re easy but necessarily entail considerable shortening, hence whenever possible

the loss of substance ought to be made good by some plastic operation. The operative treatment of certain ununited fractures, such as those of the patella, olecranon, neck of femur, etc., are described in other sections of this work.

PLASTIC OPERATIONS ON BONE

Plastic operations on bone are required to stimulate union in stubborn cases of pseudarthrosis; to fill bony defects caused by the destruction or excision of segments of bone; to replace bones congenitally absent or removed by operation.

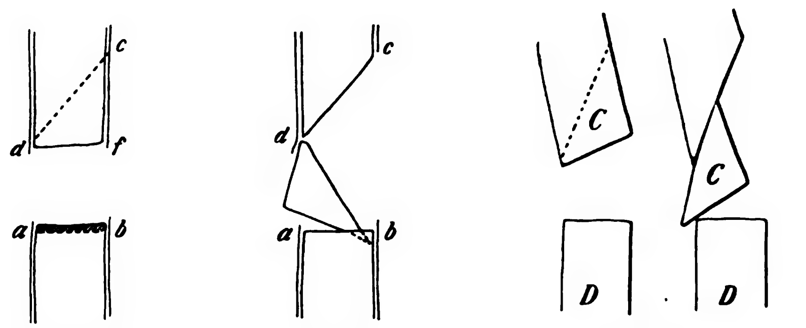


FIG. 1026. FIG. 1027.
FIGS. 1026 AND 1027.—Ollier's operation *par renversement.*

FIG. 1028.
FIG. 1028.—Ollier's operation *par glissement.*

I. **Autoplasty with Pedunculated Bone Flaps.**—1. *Ollier's operation par renversement* may be taken as a type of these procedures. Make an incision through the soft parts sufficient to expose the ends of the bone and the fibrous tissue connecting them. Excise the fibrous connection between the fragments. With a fine saw cut from one fragment a thin slice of bone along the line a b (Fig. 1026) and remove it. From the point c on the other fragment cut through

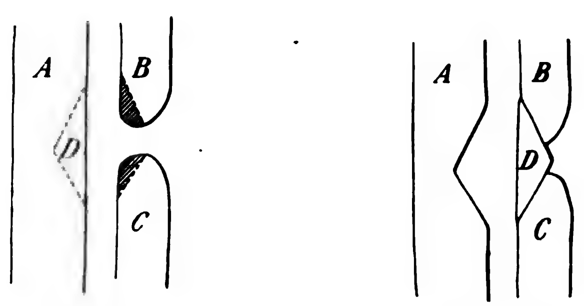


FIG. 1029. FIG. 1030.
FIGS. 1029 AND 1030.—Ollier's operation *par implantation.*

the bone along the line c d, leaving the periosteum at d undivided. The wedge of bone d c f can now be turned downwards (using the periosteum at d as a hinge) so that the apex of the wedge can be wired or stitched to the raw bone surface a b (Fig. 1027) or pushed into the medulla. In young and vigorous patients the

operation has proven satisfactory. As much as two inches of bone may be replaced in this manner.

2. *Ollier's Operation par glissement.*—From one of the fragments cut the triangle C (Fig. 1028). Be careful ***not*** to separate this portion of bone (C) from its connections with the soft parts. Slide C downwards until it comes in contact with the fragment D, the end of which must be vivified. Suture C to D.

3. *Ollier's Implantation.*—This is only suitable when one of two parallel bones is the site of anchylosis.

From the bone A cut the fragment D (Fig. 1029) preserving its connections with the soft parts. Vivify the fragments B and C. Implant the fragment D between B and C (Fig. 1030).

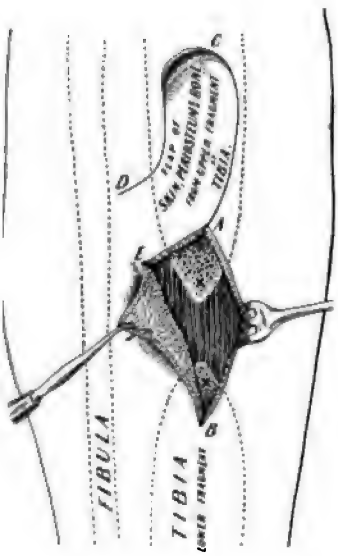


FIG. 1031.

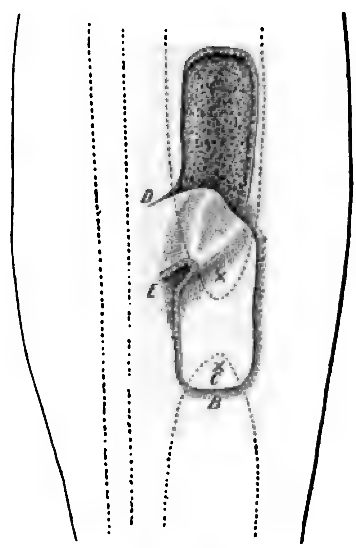


FIG. 1032.

FIGS. 1031 AND 1032.—Müller's operation.

4. *W. Müller's Operation.—Step* 1.—Expose the ends of the bone by a vertical incision, A B (Fig. 1031). Remove the interposed old scar tissue. With a chisel vivify the ends of the bone (xx).

Step 2.—Outline the flap D C E (Fig. 1031). With a chisel introduced at C cut a slice of bone from the upper fragment, thus forming a flap of bone, periosteum, and skin, which has a pedicle at D E.

Step 3.—Rotate the flap D C E so as to make it bridge the osseous defect. Fix the osseous surface of the flap to the vivified ends of bone fragments at **xx** (Fig. 1032); this may be done with sutures or pegs.

Step 4.—Close or lessen the size of the defect left by the transplantation of D E C by undermining and sliding the skin edges together or by Thiersch's grafts.

5. Müller has devised a method by which the twisting of pedicle of the flap is avoided.

Step 1.—Make the U-shaped incision A B C D (Fig. 1033), the points A and B being an inch or more above the end of the upper fragments, and the apex of the flap (C D) a similar distance below the end of the lower fragment.

Step 2.—With a chisel introduced at C D, cut a slice of bone from the lower fragment and raise it along with the corresponding periosteum and skin. Continue the dissection of flap A B C D upwards.

Step 3.—Remove the fibrous tissue from between the two fragments of bone. With the chisel vivify the end of the upper fragment of bone.

Step 4.—With the part of flap A B C D which contains bone, bridge the defect between the upper and lower fragments (Fig. 1034).

6. *Huntington's Operation* ("Annals Surg.," Feb., 1905; "California State Journ.," Oct., 1909).—Huntington's operation is suitable in cases where there

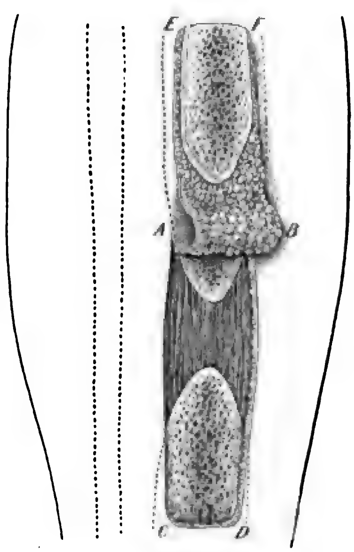


FIG. 1033.

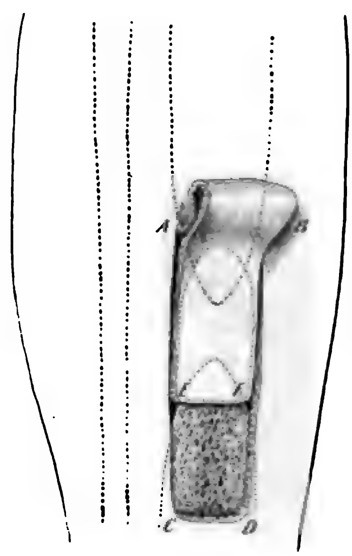


FIG. 1034.

FIGS. 1033 AND 1034.—Müller's operation.

has been extensive loss of the tibia, but the fibula remains intact. It is presupposed that any infection which may have been present is now absent.

Through an appropriate incision expose and divide the fibula at a point opposite the lower end of the upper tibial fragment and fix the fibula into a depression in the tibia. Codman ("Annals Surg.," June, 1909) carried out Huntington's operation as follows (Figs. 1035 and 1036): Make a curved incision five inches in length across the leg exposing the upper fragment of the tibia. Chisel away the tip of this fragment. Divide the fibula at a slightly higher level. Bend the leg outwards and so force the fibula into the place prepared for it in the upper fragment of tibia and push it, like a peg, for a short distance into the spongy bone. Straighten the leg. Fill the dead space left at the point where the fibula was transferred with a portion of tibialis anticus muscle. Close the wound.

Dress. Immobilize. In time there is liable to be a bowing of the foot on the fibula causing a deformity.

This led Huntington after the lapse of six months to perform a second operation as follows: Expose the upper end of the lower fragment of tibia. Vivify it. Divide the fibula at about the same level. Unite the fibula to the tibia. Close the wound. Dress. Immobilize.

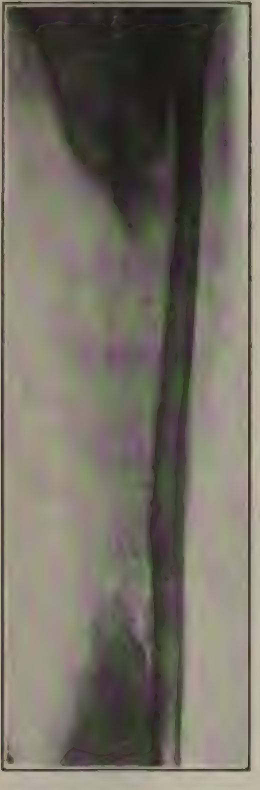


FIG. 1035.—Before operation.

FIG. 1036.—After operation.

FIGS. 1035 AND 1036.—Replacing tibia with fibula. (*Codman, Annals of Surgery.*)

Several brilliant results have been obtained by Huntington's operation. Huntington's patient walks without a limp—runs and plays foot-ball.

7. *J. S. Stone's Operation* ("Annals Surg.," Oct., 1907).—Stone's operation is practically identical with Huntington's except that he assures stability to the foot in the second operation by having *both* malleoli attached to the new tibia (Fig. 1037).

First Stage.—Implantation of the upper end of fibula into upper tibial fragment. Identical with Huntington's operation.

Second Stage.—Expose and vivify the upper end of the lower tibial fragment. Expose (without injuring the periosteum) the lower 3 inches of the fibula.

Divide the periosteum with a knife. With fine chisel and strong knife split the fibula longitudinally into two equal parts. In Stone's case "each half of the bone had a thickness of only 4 mm., scarcely over an eighth of an inch, yet

FIG. 1037.—Tibia replaced by fibula. (*Stone, Annals of Surgery.*)

in separating them for a distance of about 3 inches, 8 cm., it was essential that the periosteum remain adherent to each portion and that an equal thickness of each part be maintained throughout. It was planned to spread the halves without breaking either. This proved impossible. Fortunately the outer

rather than the inner half gave way close to the upper end of the split between them. In another case it would seem wise to insure a break in the outer half at this point rather than run the risk of breaking the inner half or the outer half at a lower level."

When the fibula has been transformed to take the place of the tibia its growth becomes much increased so that the thin splint-like bone comes to simulate the tibia in size.

8. Autoplasty by means of periosteal flaps (Codivilla's operation) is closely allied to the transplantation of pedunculated flaps of bone. Codivilla, after vivifying the ends of the bone, unites them with a wire suture and envelops this suture in a detached flap of periosteum taken from any convenient bone. Codivilla is careful to remove a thin shell of bone with the periosteum, but Brade ("Bieträge zur klin. Chir.," lxi) used the periosteum alone and obtained a good result.

Operation for Congenital Absence of Tibia.

Halstead Myers ("Med. Record," July 15, 1905) operated for the above-named condition successfully as follows: Incision across the outer half of the joint opening the articulation between the fibula and femur. The patellar ligament, thin and long, was inserted on the inner side of the fibula well below its head. The capsular ligament, and especially the external lateral ligament, were very strong and required division before the head of the fibula could be drawn downwards and inwards to a position between the condyles. The patellar ligament was shortened and attached to the anterior surface of the fibula. With sutures the articular capsule was repaired so as to aid in holding the head of the fibula in its new position. After closure of the wound at the knee, the ankle was opened by a transverse incision, the external malleolus was cut off and the cut end of the fibula planted on to the surface of the astragalus, which was denuded for that purpose. Apposition of the bones was retained by sutures. The after treatment consisted in immobilization. A year after operation the patient could flex his leg to 90 degrees, almost fully extend it, and walk about all day.

II. **Autoplasty with Non-pedunculated Portions of Living Bone.**

A. *Transplantation of portions of bone covered with its periosteum.*

Step 1.—Expose the ends of the bone. Remove interposed fibrous tissue. Freshen the ends of the fragments. Temporarily pack the wound.

Step 2.—Select the bone from which to obtain material for transplantation, the favorite ones are the tibia, the ribs, or the upper third of the ulna. Make a vertical incision down to the bone and, without disturbing the periosteum, expose it sufficiently. With a chisel, cut away a slice of bone with its periosteum large enough to bridge the defect. Pack the wound temporarily.

Step 3.—Remove the pack from the wound made in Step 1. Bridge the osseous defect by means of the "bone-periosteal" flap. Be sure that the raw surface (cut surface) of the graft lies against corresponding raw surfaces in its new berth. If necessary fix the graft in position by means of sutures. Close the wound. Apply dressings. Immobilize.

Step 4.—Remove the pack from the wound made in Step 2. Close the wound. Apply dressings.

E. Lexer ("Archiv für klin. Chir.," lxxxv, 939) publishes a remarkable contribution to our knowledge of bone transplantation.

In his clinic amputation for dry senile gangrene is common and from the limbs so amputated he obtains his material. If the implant is to be covered by periosteum still existing around the bony defect, that covering the implant must be removed, as a double layer of periosteum gives rise to exuberant and irregular development of bone. In all other circumstances, even when the implant is placed in the medullar cavity, the periosteum on the implant should be preserved. If a tubular or cylindrical bone is used as an implant and the marrow is left intact, local and constitutional disturbances commonly give trouble without infection or interference with union. To avoid these disturbances which he attributes to absorption of degenerated medullar substances, Lexer removes the marrow with a spoon and fills the resulting cavity with an iodoform plug (like Mosetig's).

Lexer has successfully implanted segments of bone (with its periosteum) 8 to 12 inches (20 to 30 cm.) in length. The bone used must be so fresh as to be still warm. See p. 901, Murphy on transplantation of bone.

B. *Transplantation of part of the whole thickness of the shaft of a bone plus one of its articulating ends.*

Transplantation combined with arthroplasty.

A good example of the above is the following: In a case of sarcoma of the upper end of the humerus, Rovsing ("Hospitalstidende," iii, No. 1. Ref. "Journ. de Chir.," March, 1910) excised the diseased bone and implanted a segment of fibula.

Step 1.—Make a curved incision following the borders of the acromion process and through this penetrate the shoulder-joint. Beginning at this incision make a longitudinal cut down the outer surface of the arm to a point well below the disease.

Step 2.—Excise the desired portion of the humerus *plus* its periosteum and the muscular insertions so as to keep away from the disease. If the long head of the biceps is involved in the disease excise it also.

Step 3.—Attend to hemostasis and pack the wound temporarily with gauze.

Step 4.—Expose the upper end of the fibula through a longitudinal incision, being careful to retract uninjured the external popliteal nerve. Open the superior tibio-fibular articulation.

Step 5.—Mobilize a segment of the fibula about 3 cm. longer than the segment of humerus which was removed and excise it, *but leave* "a sort of muscular sheath about 1 cm. thick attached to it."

Step 6.—With a chisel sharpen the lower end of the fragment of fibula and force it into the medullary cavity of the diaphysis of the humerus.

Step 7.—With sutures fasten the remains of the articular capsule of the shoulder-joint to the fibula and the soft parts of the arm to the muscular tissue left attached to the implanted fibula.

Step 8.—Close the wound. Apply dressings.

In Rovsing's case free passive motion was possible two months after operation and the patient was able to use the arm in carrying food to his mouth.

Operations similar to or identical with Rovsing's have been performed by a number of surgeons.

C. *Transplantation of fragmented bone with or without periosteum.* (Macewen's method.)

Step 1.—Expose the ends of the bone. Remove interposed fibrous tissue. Freshen the ends of the fragments. Temporarily pack the wound.

Step 2.—Obtain fragments of bone as in method A, or from a patient on whom cuneiform osteotomy is necessary. If there is any delay between obtaining the fragments and their implantation, be careful to keep them in warm salt solution or wrapped in warm, moist gauze. With a chisel cut the pieces of bone to be implanted into small fragments.

Step 3.—Fill the gap between the freshened ends of the bone to be united with the osseous fragments obtained as above.

Step 4.—Close the wound without drainage. Apply dressings. Immobilize. The implantation of fragmented bone has given some brilliant results.

III. **Transplantation of Dead Bone.**

A. *Decalcified Bone Chips.*—On the theory that the fragments implanted according to the preceding method do not grow, but merely act as scaffolding, to be replaced by osseous material supplied by the ends of the fractured bone, some surgeons have used in their place chips of decalcified bone. The preparation and use of decalcified bone chips is described elsewhere.

B. *Transplantation of Large Fragments of Dead Bone.*—Kausch ("Beiträge z. klin. Chir.," lxviii, p. 670) after removing the upper end of the tibia for sarcoma implanted a corresponding portion of a tibia obtained in the course of an amputation some days previously. The implant was deprived of its periosteum and marrow, was carefully boiled and soaked in ether to remove its fat. There was complete operative recovery, but recurrence of the sarcoma necessitated amputation nine months later, when examination showed the implant firmly united both to the femur and the tibia and enveloped in a new formed periosteum. Küttner ("Zentralblatt für Chir.," 1910, No. 31) excised the upper third of the femur for osteosarcoma, and at once implanted a similar portion of femur obtained from a man who had been operated on for coma due to tumor of the brain and died without regaining consciousness. The upper end of the femur along with its head was removed under aseptic precautions eleven hours after death and was preserved for twenty-four hours in salt solution to which some chloroform had been added. Six weeks after operation the result was promising.

IV. After removing a central enchondroma from a phalanx, Primrose implanted an ivory peg of suitable size and shape. A skiagram taken fourteen weeks later showed the peg partially absorbed but surrounded by a satisfactory amount of good bone. Primrose's operation, as well as those in which joints are transplanted from fresh cadavera, are all anticipated in Th. Gluck's almost prophetic article published in the Archiv für klin. Chir., xli, 1890.

CHAPTER LXVIII

FRACTURES. MALUNION

When fractures have solidly united in bad position or with an excess of permanent callus, deformity results. The deformity is often of no importance, but when it is disfiguring or disabling, operation may be proper; when it is disabling, operation may be obligatory.

(A) When excessive callus causes injurious pressure on important nerves or vessels, cut down upon the callus and with a chisel or rongeur forceps remove

FIG. 1038.—Badly united fracture.
Line of section.

as much of it as may be necessary. Sometimes it is wise, after freeing the nerve or vessel from injurious pressure, to interpose a flap of fascia or muscle between these structures and the bone.

(B) Malunion without much shortening, but in a more or less angular position, requires the same operative treatment as similar deformities due to other causes. See Osteotomy.

If a moderate amount of shortening is present an oblique osteotomy will not only correct the angular deformity, but may permit the desired amount of lengthening to be obtained (Fig. 1038).

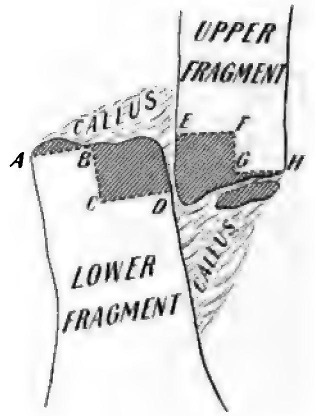


FIG. 1039.

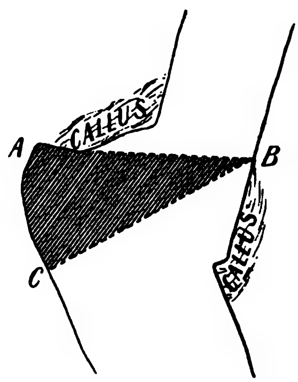


FIG. 1040

(C) **Malunion with Much Shortening Owing to "Overriding" of the Bones.**—The treatment of this condition consists in osteotomy, if necessary *plus* fixation of the bones as in pseudarthrosis. Figures 1039 and 1040 sufficiently explain the general plan of operation. It must be remembered that contraction of the soft parts must be overcome before apposition in good position can be obtained or maintained. For this purpose extension by means of the weight and pulley or suitable apparatus is often sufficient, but it must frequently be supplemented by tendon lengthening, by tenotomies, or by fasciotomies.

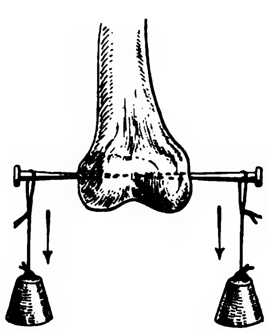


FIG. 1041.

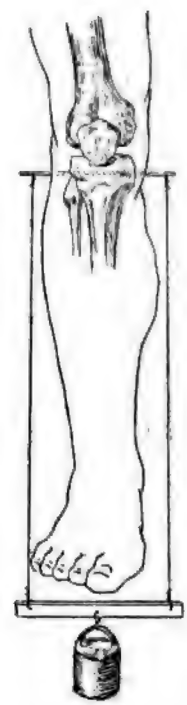


FIG. 1042.—(*Payr.*)

FIGS. 1041 AND 1042.—Direct traction apparatus.

Direct Application of Extension Apparatus to Bones.—Codivilla and Steinmann have each recommended that extension be applied directly to bones and thus better results be obtained than where the extension is exerted through adhesive plaster applied to the skin. The application of the principle is simple and safe provided the asepsis is perfect. There are two methods by which direct extension may be applied: 1. Make a puncture down to the bone. Drill a hole completely through the bone. Introduce a skewer through the bone and make it protrude through a puncture in the skin on the opposite side of the limb. Apply dressings to the punctures, around the protruding ends of the skewer. Attach strings to the end of the skewer and a weight to the strings. 2. On one side of the limb make a puncture down to the bone through the puncture fasten a nail or drill securely into the bone. Do the same on the opposite side of the bone and attach weights to the nails by means of cords or calipers (Figs. 1041 and 1042.) The first of these methods is by far the better.

FIG. 1043.—(*Steinmann.*)

It may be useful to describe in some detail the operative treatment of one or two well-known examples of malunion.

I. **Malunion in Colles's Fracture.**—The lower fragment of the radius is tilted dorsally on the upper fragment and has become united there, causing the classic "silver fork" deformity.

Dawbarn's Operation.—*Step* 1.—Expose the line of union by a longitudinal incision along the outer side of the bone. Reflect the periosteum along with the rest of the parts from the outer side of the bone. Avoid injuring the radial nerve.

Step 2.—With a fine chisel or osteotome divide the line of union between the two fragments. Correct the deformity and after closing the wound treat as an ordinary Colles's fracture. After correction there is frequently a gap left between the two fragments. This gap may be filled in one of two ways.

Step 3.—(A) At a point midway between the wrist and elbow, make an incision down to the ulna. From the ulna excise a segment of bone equal to the gap in the radius. Unite the divided ulna *secundem artem.* The resultant shortening of the ulna permits apposition of the fragments of the radius. The whole forearm is of course shortened.

(B) Remove from the ulna a much smaller segment of bone. With the chisel cut this segment into small fragments and implant them between the fractured surfaces of the radius. The advantage of method B is that there is less shortening of the forearm than with method A.

(C) Possibly the gap might be filled by a modification of Ollier's autoplastic operation (p. 907).

FIG. 1044.—Separation of lower femoral epiphysis, before operation.

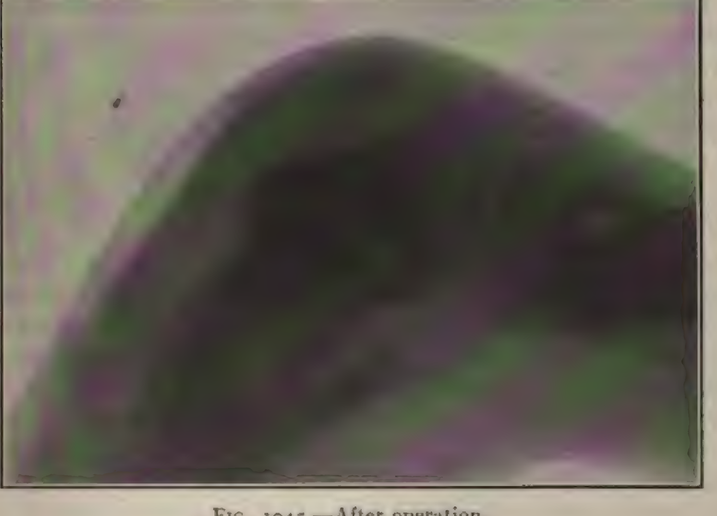


FIG. 1045.—After operation.

Remarks.—H. A. Lothrop ("Boston Med. and Surg. Journ.," Dec. 7, 1905) finds that the deformity from unreduced Colles's fracture can usually be corrected by manipulation, under an anesthetic, during the first three weeks after injury; that after two to six months an operation on the lines of Dawbarn's should always improve the position and frequently the function; that after six months, while it is easy to correct backward and upward displacement, lateral displacement is hard to overcome and usually requires osteotomy of the ulna. The late operation, according to Lothrop, rarely improves function.

II. Malunion after Separation of Lower Femoral Epiphysis.—The epiphysis is usually dislocated forwards and upwards and remains in contact with the diaphysis. There may be much callus. Where fair mobility of the knee is retained or expected, operative reduction is positively indicated; where anchylosis is present an osteotomy may give as good results with less risk.

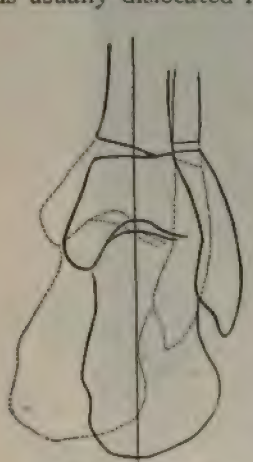


FIG. 1046.—Correction of deformity after Pott's fracture. (*Feiss, Surgery, Gynecology and Obstetrics.*)

(A) **Operative Reduction.**—*Step* 1.—Expose the line of union by a longitudinal incision on one or both sides of the limb.

Step 2.—With the elevator separate the periosteum and soft structures *together* from the sides of the bone at the line of union. With the osteotome divide the line of union. By manipulation reduce the fracture. Before obtaining reduction it may be necessary to pare off some bony prominences or excrescences and to divide or lengthen the hamstrings. After reduction the fragments may be held in apposition by sutures, nails, bone pegs or buried metallic splints.

Step 3.—Close the wound with or without drainage. If a tourniquet (elastic constrictor) has been used, the author provides drainage, applies dressings and splint, and only removes the tourniquet after the patient has been put to bed with the limb fixed in a vertical position. After twenty-four hours the limb may be gradually lowered.

Figures 1044 and 1045 show a case before and after the above treatment was carried out.

(B) **Osteotomy.**—When from any cause operative reduction is inappropriate, the deforming flexion may be overcome by osteotomy.

In a case of much disability due to malunion after Pott's fracture, Feiss ("Surg., Gyn., Obst.," June, 1909) corrected the deformity and restored the weight-bearing line by making a linear osteotomy on the tibia and a cuneiform osteotomy on the fibula, Fig. 1046 is self-explanatory. The result was very gratifying.

CHAPTER LXIX

SPECIAL FRACTURES

I. Fractures of the neck of the femur, whether involving the neck alone or with it the trochanter.

(A) **Excision of the Head or Fragments.**—Expose the joint by Hueter's anterior incision and remove the fragments. No special description is necessary.

(B) **Nailing the Fragments** (Langenbeck, König, Trendelenburg, etc.).—*Step* 1.—Make a short vertical incision over the outer surface of the trochanter major and expose the bone.

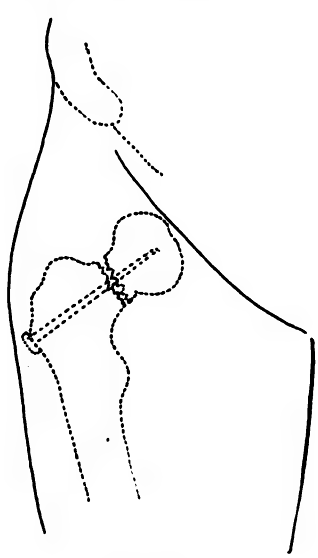


FIG. 1047.

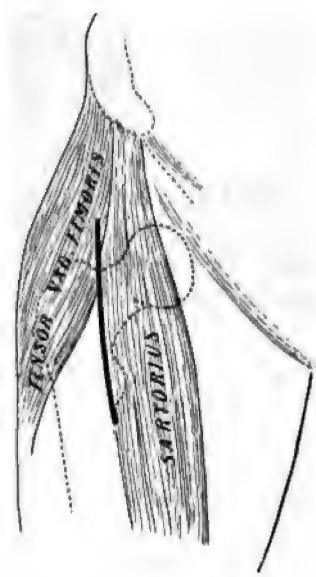


FIG. 1048.—Hueter's incision.

Step 2.—By traction reduce the fracture.

Step 2.—With a drill bore a hole through the trochanter and into that part of the neck attached to the head. Replace the drill by a screw nail or bone peg (Fig. 1047).

Step 4.—Dress. Apply traction and immobilizing apparatus. (Note: Instead of the screw nail or peg, the Parkhill-Freeman device may be used.)

(C) **Systematized Operation.**—*Step* 1.—From a point midway between the trochanter major and the anterior superior spine make an incision, 4 to 6 inches long, downwards, parallel to the outer margin of the sartorius muscle (Fig. 1048) (Hueter's incision). By blunt and sharp dissection penetrate to the

hip-joint between the sartorius and the tensor vaginæ femoris muscles. A few fibres of the vastus externus require division. Remember the external circumflex artery which runs transversely immediately below the trochanter.

Step 2.—Retract the soft parts. The fracture will now be visible. Note that the capsule of the joint and its reflection over the femoral neck are torn.

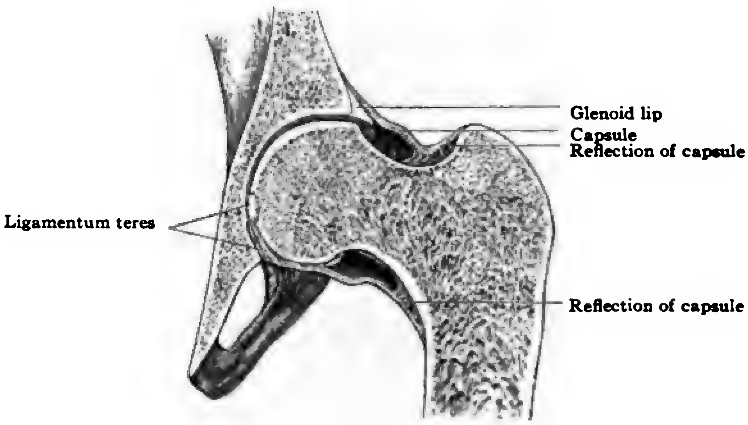


FIG. 1049.—(*Morris.*)

Remove blood, etc., from the wound. If possible, by rotation of the limb expose the capsule posterior to the joint and repair the tear in it with sutures (Fig. 1049). Remember that the most important portion of capsule reflected on the femoral neck lies below the neck.

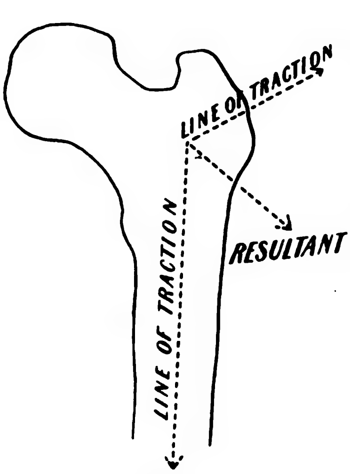


FIG. 1050.

Bring the fractured surfaces of bone into good apposition and fix them in position (*a*) by using method B guided by the finger and eye through the open wound (*b*) by means of wire sutures.

Repair the tear in the capsule reflected on to the neck of the femur. Repair the main rent in the capsule. Close the wound in the soft parts.

Step 3.—Applying dressings. Immobilize.

J. E. Moore ("Northwestern Lancet," March 1, 1904), apropos of a case of ununited fracture on which he operated, remarks that the nail used for fixation might have been omitted with advantage and the Maxwell method of extension used alone. This suggestion applies equally to cases of recent fracture of the femoral neck whether operated on or not. The method consists in applying extension by weight and pulley in the directions shown in figure 1050, the resultant force being in the long axis of the neck of the femur.

Gurlt, Fritz König, and others have noted that in true intracapsular fracture the head of the femur deprived of nourishment soon undergoes degenerative changes which unfit it for union even after operation, hence F. König advises operation at the end of eight days. Fractures of the neck involving the trochanter rarely require operation. Impacted fractures do not call for operation unless they cause disabling deformity. Fred Cotton in fractures of the neck of the femur produces impaction. Having placed the bones in good position by traction and manipulation, he covers the region of the trochanter with some layers of felt and then with a large wooden mallet delivers a swinging blow to the trochanter in the direction of the neck of the bone. Impaction, having

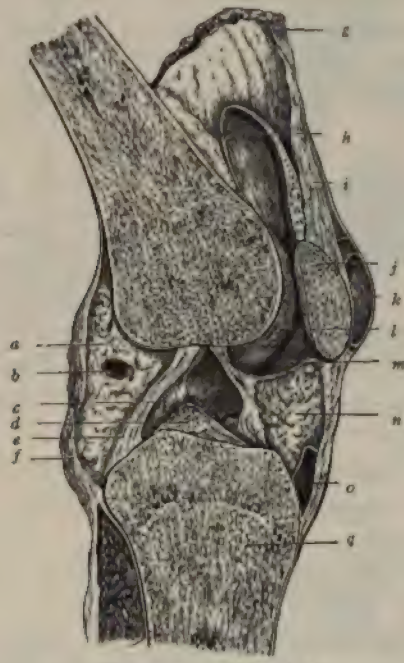


FIG. 1051.—(*Morris.*)

a, Fat; *b*, Opening in synovial membrane behind crucial ligament leading into inner half of joint; *c*, synovial membrane reflected off crucial ligament; *d*, cut end anterior crucial ligament; *e*, post. crucial ligament; *f*, oblique popliteal ligament; *g*, quadriceps; *h*, synovial sac; *i*, tendon quadriceps; *j*, patella; *k*, bursa; *l*, condyle femur; *m*, patellar synovial fold; *n*, patty cushion; *o*, bursa; *p*, tibia.

been secured, immobilization for six or eight weeks is practised. The author believes operation to be rarely indicated in fresh fractures of the femoral neck in the aged. Maxwell and Ruth's results of conservative treatment are most encouraging ("Journal Am. Med. Association," April 9, 1904), but considering how badly the aged bear the necessary confinement in bed, the writer prefers to trust to massage, and almost immediate passive and active motion, the result being of course pseudarthrosis, but almost always a useful limb.

If operation is chosen, which method offers most? Method B means working in the dark and entirely neglects restoration of the joint capsule which has a most important influence on the nutrition of the head of the bone.

Method C is no more dangerous than methods A and B, but **permits repair** of capsule. One of F. König's cases ("Archiv für klin. Chir.," lxxv, 725) demonstrates admirably the importance of this step. Of course if the **head of the** bone is too severely injured it ought to be removed.

II. Fractures at the Lower End of the Femur.

(A) **Transverse Fractures.**—Operative treatment is practically the same as that for separated epiphysis.

(B) **Separation of Lower Femoral Epiphysis.**—*Step* 1.—As the knee-joint is usually unopened by the injury, endeavor to avoid penetrating it. Figure 1051 shows the normal extent of the synovial sac. "The obstacle to reduction is no single band or obstruction, it is the retraction and tension maintained by the fascia, ligaments, and muscles of the thigh upon the tibia. This retraction is so great that the tibia is held crowded against the lower end of the upper fragment, and prevents the replacing of the epiphysis" (Scudder).

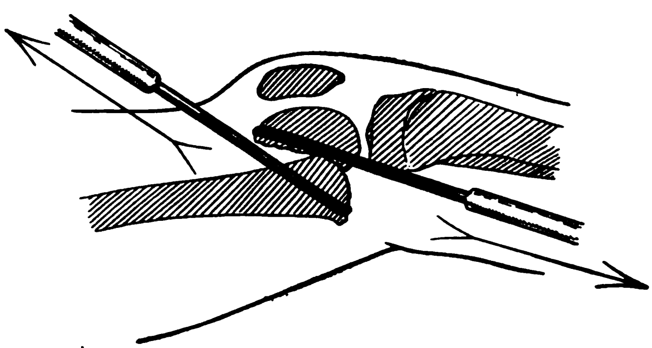


FIG. 1052.—Separation of lower femoral epiphysis. (*Scudder.*)

Step 2.—Make an external longitudinal incision freely exposing injured shaft and epiphysis.

Step 3.—With strong hooks make traction on the diaphysis and eipiphysis (Fig. 1052) or attain the same purpose by other means. During the above manœuvre slowly flex the knee and so reduce the displacement.

Step 4.—If the fragments tend to remain in good position, pass on to Step 5. If the fragments do not tend to remain in good position apply periosteal sutures (good in any case) or bone pegs of any or the established means of fixation. It is more important to avoid irritating means of fixation in case of epiphyseal separation than in other fractures because of their possible evil effect on subsequent growth.

Step 5.—Close the wound. Apply dressings. Immobilize for three or four weeks in the flexed position. After this time the leg may be extended, but the use of plaster of Paris or splints ought to be kept up for about six weeks from the date of operation.

Figures 1044 and 1045 show separation of the femoral epiphysis before and after operation.

(C) **Fractures of the Condyles of the Femur.**—A small amount of deformity after fractures involving the knee-joint means much disability, hence operative reduction and fixation are often indicated.

Step 1.—Expose the site of fracture by an internal or external longitudinal incision. This opens the joint.

FIG. 1053.—(*Alglave.*)

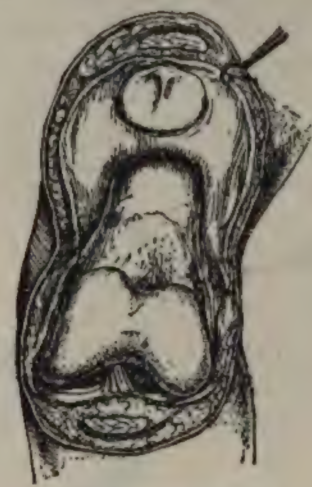


FIG. 1054.—(*Handley.*)

Step 2.—Reduce the fracture and fix it in proper position by some of the means already described. The author prefers bone pegs.

Step 3.—Remove any blood and detritus which may be present in the knee-joint. Close the wound with or without drainage.

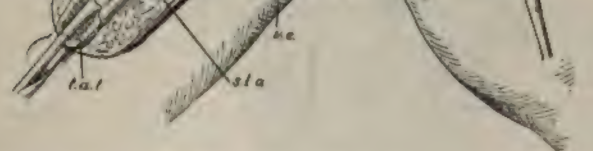


FIG. 1055.—(*Alglave.*)

Step 4.—Dress. Immobilize in the extended position. Elevate the limb for twenty-four hours. As soon as possible begin massage especially of the quadriceps extensor femoris.

Sampson Handley ("Brit Med. Journ.," Oct. 5, 1912), and Alglave ("La Presse Med.," Nov. 19, 1912) both recommend transarticular exposure of the

bone in so-called T fractures of the lower end of the femur. The parts are exposed as in excision of the knee by Method E, p. 1055, where the tendo

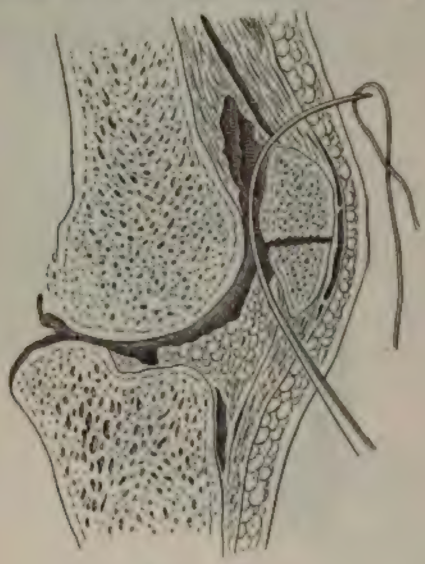


FIG. 1056.

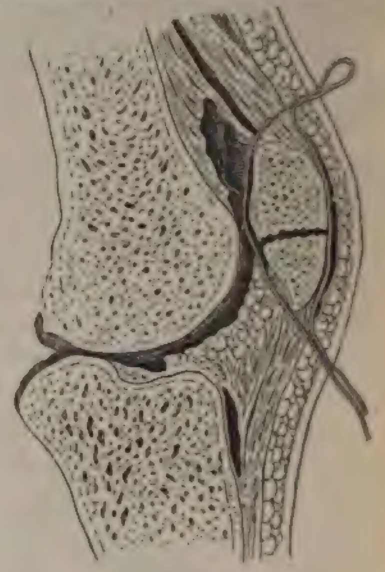


FIG. 1057.

FIGS. 1056 AND 1057.—Barker's operation.

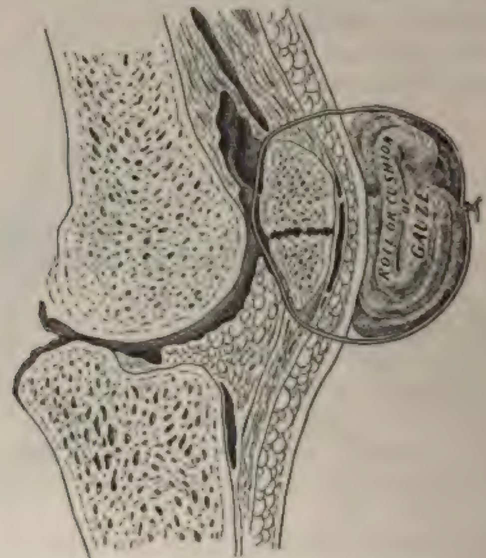


FIG. 1058.—Barker's operation.

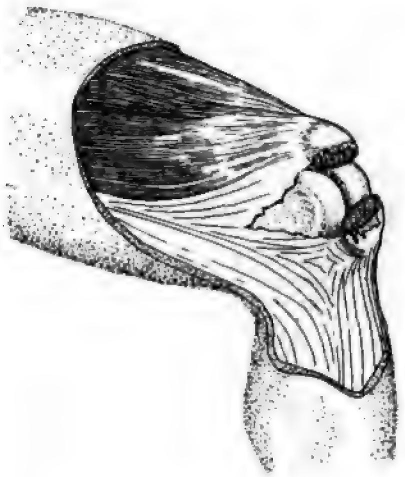
patellæ is divided and an anterior flap including the patella is thrown upwards (Fig. 1054). Alglave recommends that the tuberosity of the tibia be cut from the bone by a chisel instead of the tendon being divided. It is easy to replace

ıberosity and fix it with a wire nail. Fig. 1055 shows the exposure ob-
l. A lateral incision plus division of the tuberosity may give sufficient
; (Fig. 1053).

I. **Fracture of the Patella.**

.) **Subcutaneous Methods of Fixation. Barker's Method.**—*Step* 1.—
a long, strong, curved needle with an eye near its point through the skin
endo patellæ immediately below the lower fragment. Guide the point
: needle upwards through the knee-joint, close to the posterior surface of
atella and make it emerge immediately above the upper fragment after
ıg through the quadriceps tendon (Fig. 1056).

ep 2.—Thread the needle with a strand of strong soft silver wire. With-
and unthread the needle.



1059.—Torn fascia impaled on spicules of bone preventing apposition of fractured fragments. (*After Helferich.*)

ep 3.—Through the same opening reintroduce the needle and pass it
rds close to but in front of the patellar fragments. Make it emerge
gh the spine opening above (Fig. 1057).

ep 4.—Thread the needle with the end of wire protruding through the
opening and withdraw it. The wire now surrounds the broken bone.

ep 5.—Approximate the fragments of bone. Tighten the wire and twist
o ends snugly. Cut off the excess of wire. Bury the twisted part of the
ꞁeneath the skin, if necessary enlarging the original needle puncture for
urpose with a knife.

modification of Barker's method is as follows: Steps 1 and 2 as above.
3.—Approximate the fragments of bone. Apply a firm pad over the
a. Bring the ends of the wire over the pad and twist them tight (Fig. 1058).

) **Open Operation.**

) **Classical Operation.**—*Step* 1.—Make a vertical incision in the middle
·om a point about one inch above the upper fragment to a similar point

below the lower fragment. Reflect the soft parts (exclusive of the periosteum which must not be disturbed) to either side so as to freely expose the fractured surfaces.

Step 2.—Remove effused blood from the knee-joint by douching with salt solution and by gentle mopping with moist gauze.

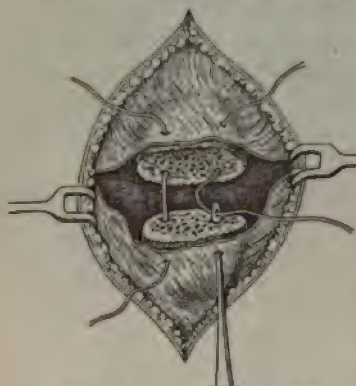


FIG. 1060.—Wiring patella.

Macewen noted ("Annals Surg.," v, 177) that the principal obstruction to bony union was tags of torn fascia and periosteum which curl in between the fragments and become fixed to the fractured surfaces by becoming impaled on the protruding spiculæ of bone (Fig. 1059). Remove all interposed tissue; in old cases of non-union this requires that the surfaces of the bone be pared or freshened with the chisel or saw.

Step 3.—With a drill bore two sets of holes through corresponding parts of the upper and lower fragments without encroaching on the articular surface (Fig. 1060), and through these pass sutures of wire or chromicized catgut. It is easy to pass wire through the holes in the bone, but when pliable material or catgut is used it is well to use a drill provided with an eye or notch near the

FIG. 1061.—(*Stimson.*)

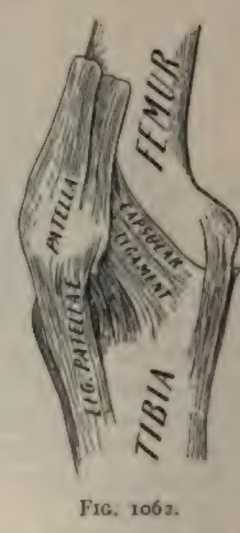


FIG. 1062.

point by means of which the suture may be pulled into place as the instrument is withdrawn.

Step 4.—Reduce the fracture. Tighten and fix the sutures. If wire is used after it has been fixed by twisting, cut off any excess of material and by hammering flatten the projecting knot. If the case is an old one, contracture

: quadriceps may so interfere with approximation as to require lengthen-
' the muscle or tendon.

ep 5.—Close the wound in the soft parts. Apply dressings. Immobi-
ı the extended position. Elevate the limb for twenty-four hours.

) **Stimson's Operation. Mediate Silk Suture.**—*Steps* 1 and 2 as in
:al operation.

ep 3.—With a full curved needle pass a stout silk ligature transversely gh the ligamentum patellæ close to the apex of the patella, then trans-y in the opposite direction gh the quadriceps tendon close insertion. Approximate the frag-; (Fig. 1061). Tighten and tie uture.

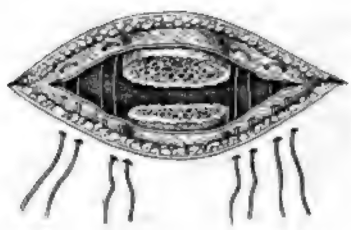
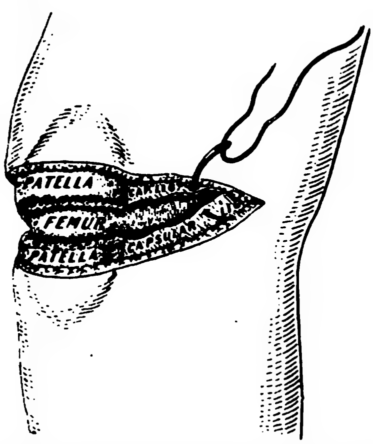


Fig. 1064.



IG. 1063.—Suture of capsular ligament.

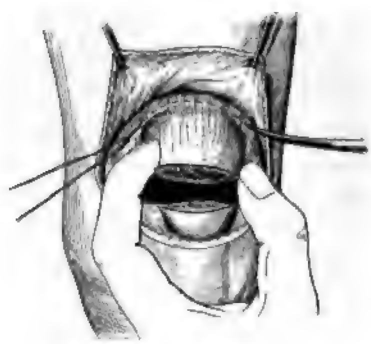


Fig. 1065.—(*Labey.*)

tep 4.—Place one or two catgut sutures in the torn capsule on either side.

tep 5.—Close the wound. Dress. Immobilize.

;) **Vallas's Operation. Suture of Capsule.**—This operation is based on act that when the patella is fractured transversely there can be but little ation of the fragments unless the fibrous capsule of the joint (fibrous ex-ion of the quadriceps; capsular ligament) is also torn (Fig. 1062).

tep 1.—Expose the fracture as in the classical operation by a vertical in-ı. A more generous exposure may be obtained through a crucial or a trans- incision, or by reflecting a U-shaped flap of skin having its base directed r upwards or downwards. The writer has usually employed a transverse on, but the simple vertical one is probably sufficient.

tep 2.—As in classical operation.

tep 3.—Carefully inspect the torn fibrous capsule on either side of the la. If necessary trim its torn edges. With catgut close the wound in the ıs capsule on each side of the patella (Fig. 1063); when this is done the frag-s of bone will be found in apposition and no special bone sutures will be

required. Suture the torn fascia and periosteum over the patella. Vallas uses the transverse incision and silver wire U-sutures for the capsule, which are removed after eight days. A glance at Fig. 1064 shows the method of their introduction ("Rev. de Chir.," Oct., 1899). Murphy after suture of the capsule surrounds the patella with wire in the manner shown in Fig. 1067. The wire neither penetrates the bone nor the joint. During the whole operation no finger should touch the wound, and Murphy insists that the synovialis must not be

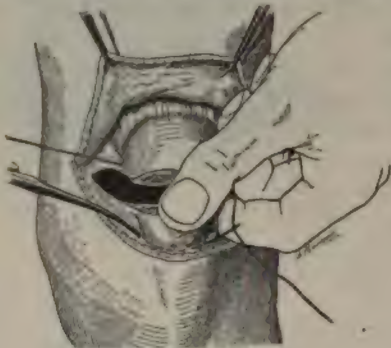


FIG. 1066.—(*Labey.*)

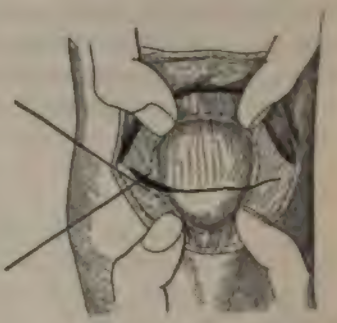


FIG. 1067.—(*Labey.*)

touched even by instruments or gauze lest its endothelial covering be impaired.

Step 4.—Close the external wound. Apply dressings. Immobilize in a position of extension.

(4) **Purse-string Suture of Patella.**—Expose the bone and prepare for union as already described. With a long needle (*e.g.*, Reverdin's) make a strong silver wire encircle both fragments of the patella (Figs. 1065, 1066, 1067). Approximate the fragments. Tighten and fix the wire by twisting. With

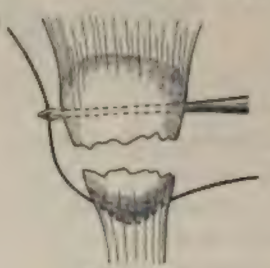


FIG. 1068.

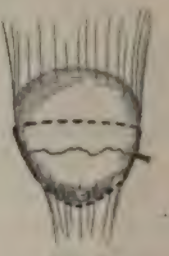


FIG. 1069.

sutures close the rent in the fibrous capsule and suture the fascia and periosteum over the patella. Close the external wound.

(5) **Modified Purse-string Suture of Patella. Quenu's Operation.**—This is suitable when one of the fragments is much smaller than the other. Figures 1067 and 1068 sufficiently describe the method.

Fracture of the Patella with Wide Separation of the Fragments. Lister's Operation in Two Stages.—*Stage* 1.—Make a short longitudinal incision over each of the fragments (Fig. 1070, AB and CD).

Step 2.—Drill two holes in the upper fragment and pass the ends of a stout wire through them from without inwards (Fig. 1071).

Step 3.—By blunt dissection make a tunnel under the skin from the lower incision CD to the upper one AB. Pull the ends of the wire through the tunnel to emerge at CD.

Step 4.—Bore two holes through the lower fragment of the patella corresponding to the holes bored in the upper fragment. Pass the ends of the wire through these holes from within outwards (Fig. 1072).

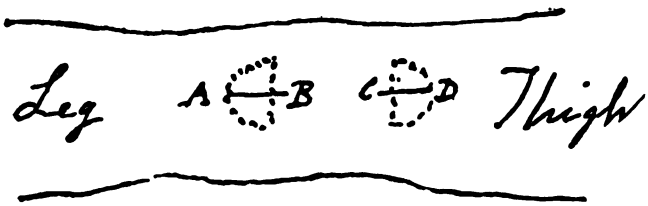


FIG. 1070.—(*Lister.*)

Step 5.—Flex the thigh; extend the knee; with a strong sharp hook pull the upper fragment of the bone downwards; tighten the wire stitch and fix it by twisting. Close the wounds. Apply a posterior splint. Keep the limb elevated (in vertical position to relax the quadriceps) for two or three days. Gradually lower the limb. The object of the operation is to bring the fragments moderately close together—if this is done, the quadriceps will stretch to such an extent that at a secondary operation the broken surfaces of the patella can be freshened and brought into correct apposition. (The diagrams here used are reproductions of Lord Lister's rough sketches with autograph explanations ("Brit. Med. Journ.," April 11, 1908.)

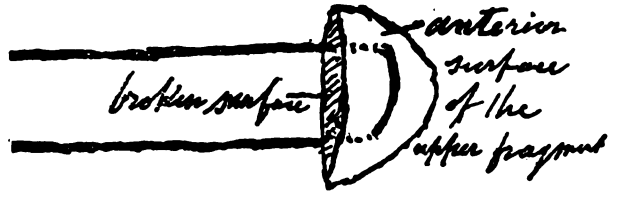


FIG. 1071.—(*Lister.*)

Lynn Thomas attained the same end by chiseling the tubercle of the tibia from its seat, being careful not to detach the tendinous and periosteal attachments along its inner edge. Separation of the tubercle of the tibia permits the easy approximation of the fractured surfaces of the patella. If necessary the tubercle may be fixed in its new position by means of a nail.

Rotter's Operations ("Zentralblatt für Chir.," 1908, No. 17).—In a case of old patellar fracture where there was much separation of fragments and much disability, Rotter operated as follows:

(1) Exposure of the parts by means of a curved incision.

(2) Excision of scar tissue.

(3) Transverse perforation of each fragment and introduction of a wire suture. This only gave a slight degree of approximation.

(4) Formation of a flap from the aponeurosis of the rectus femoris. This flap had its base at the upper edge of the upper fragment of the patella and was long enough to reach to the ligamentum patellæ.

(5) Application of the fascial flap over both fragments of patella and suture of it to the ligamentum patellæ and to the vivified anterior surfaces of the bone fragments.

(6) Suture of the wounds in the capsule of the joint. (To the author this seems to be the most vital step in the operation.)

Immobilization for seventeen days. After eight months the functional result was good. The silver wire was found to have broken.

Occasionally the patella will be so comminuted in an open fracture that its repair is evidently impossible. Under these conditions it is wise to remove all the fragments and detritus, to repair all injuries sustained by the fibrous capsule of the joint, and to put the patellar periosteum and the patellar and quadriceps tendons in as favorable a condition for repair as is possible.

upper fragment

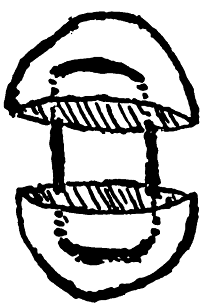


FIG. 1072.—(*Lister.*)

lower fragment

Indications and Choice of Operation in Patellar Fracture.—1. When the fragments are separated as much as one finger-breadth (¾ inch), operate.

2. When there is no such separation, or examination is difficult because of pain and swelling, keep the patient in bed, apply a posterior splint, treat the knee with elastic pressure and massage. After about one week, proper examination will be possible. Ask the patient to lift his heel up from the plane of the bed to the slightest extent and not more. If he can do this, operation is unnecessary; if he cannot, then operate.

3. The best time to operate is during the second week after injury. Murphy thinks that the knee should be at once injected with about 15 c.c. (ʒ. iv) of 2 per cent. formalin glycerine and Buck's extension applied with a weight of about 20 lbs. After the lapse of from 5 days to a week operation is safe. Arbuthnot Lane operates at once.

4. None of the subcutaneous operations permit removal of fascia from between the fragments, nor do they repair the injured and important fibrous capsule, hence they are objectionable.

5. All the methods in which material which might prevent union is removed, and in which the torn fibrous capsule is repaired, are satisfactory. The author prefers Vallas' operation.

6. When the bone is much comminuted, the purse-string suture may be e most suitable.

After-treatment.—Vallas and Murphy represent two extremes in the matter after-treatment.

1. Vallas' advice. About two weeks after operation begin massage of the igh. Encourage the patient to contract the quadriceps muscle, without, wever, doing it to such an extent as to cause pain or jeopardize union. About ree weeks after operation begin massage of the whole limb, use passive, and, ter, active motion.

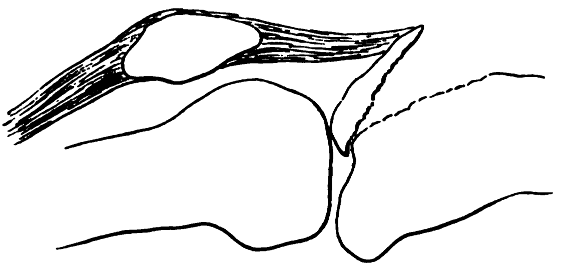


FIG. 1073.—Fracture of tibial tubercle.

2. Murphy's advice. Use Buck's extension (15 to 25 lbs.) and a posterior ire trough splint. Begin passive motion in five weeks. Use a mechanical upport for ten weeks.

IV. Fracture of Tubercle of Tibia.*—When the tubercle of the tibia is orn from the bone it may be pulled upwards a distance of four inches; but his is exceptional, about two inches being the usual displacement. With the tubercle a portion of the tibial cortex may be torn off and this may remain

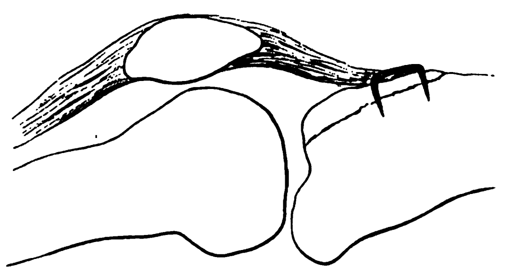


FIG. 1074.—Fracture of tibial tubercle.

nore or less attached by its upper end to the articular surface of the bone. The fractured fragment of bone may become wedged into the knee-joint Fig. 1073).

Operative Treatment.—*Step* 1.—Freely expose the site of injury by a ertical or, better, by a horseshoe-shaped incision having its base above. If he knee-joint is involved, wash all blood-clots, etc., out of it.

* For a full discussion of the accident and its treatment see Gaudier and Bouret, "Rev. de hir.," Sept., 1905.

Step 2.—Reduce the fracture. To do this satisfactorily it may be necessary to pass a strong suture transversely through the tendo patellæ as a tractor. The suture may be eventually used as a means of fixation by passing it through a hole bored in the tibia.

Step 3.—Unite the fractured tubercle to the tibia by means of periosteal sutures or of bone pegs, nails, or a wire suture (Fig. 1074). If the knee-joint is open, close it with sutures.

Step 4.—Close the external wound without drainage. Dress. Treat like fractured patella.

Fractures of the external malleolus often lead to impairment of movement of the ankle-joint. This is due to the fact that the fracture opens the joint and the subsequent callus formation leads to a chronic inflammation of the joint. Bland-Sutton ("Lancet," Feb. 7, 1914) reports three cases in which he removed the detached malleolus and obtained a quick convalescence and perfect function in each. The support which the malleolus normally gives the ankle-joint is restored by a thick fibrous mass of tissue. This measure carries out a principle of Bland-Sutton's which he has long practised, namely, the removal of small fragments of the detached bone in fractures involving joints.

V. **Fracture of Tuberosity of Os Calcis.**—This fracture almost always requires fixation by operation.

Method A.—Reduce the fracture by manipulation. Make a very small incision (puncture) down to the middle of the posterior surface of the fragment of bone attached to the tendo Achillis. Drill a hole through the fragment and into the body of the os calcis. Substitute a nail or a bone peg for the drill (Fig. 1075). If necessary, close the skin wound with a stitch. Immobilize in a position of plantar flexion with the knee flexed.

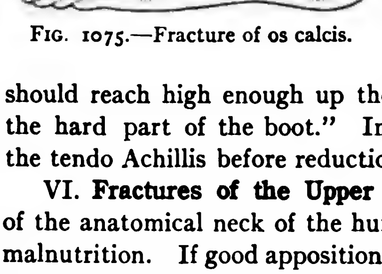


FIG. 1075.—Fracture of os calcis.

Method B.—Is the same as A except that the site of injury is exposed by turning down a flap of skin, with its convexity upward. Cheyne and Burghard advise that "the flap should reach high enough up the back of the ankle to escape friction from the hard part of the boot." In old cases it may be necessary to lengthen the tendo Achillis before reduction is possible.

VI. **Fractures of the Upper End of Humerus.**—Non-impacted fractures of the anatomical neck of the humerus rarely result in bony union, because of malnutrition. If good apposition cannot be obtained (as shown by Skiagraphy) the best treatment is to excise the head of the bone through an incision along the anterior border of the deltoid. It may be well to supplement the excision by enveloping the fractured surface of the upper end of the humerus in a flap of fat and fascia so as to insure as much as possible against anchylosis. Fractures of the surgical neck and those through the neck and the tuberosities

are to be treated by operation when the X-ray demonstrates the futility of conservative measures.

Occasionally the greater, rarely the lesser, tuberosity is in whole or in part detached from the humerus. Fritz König believes the accident much more common than is usually supposed as an accompaniment of luxations and of fractures through the tuberosities. To diagnosis it accurately necessitates the

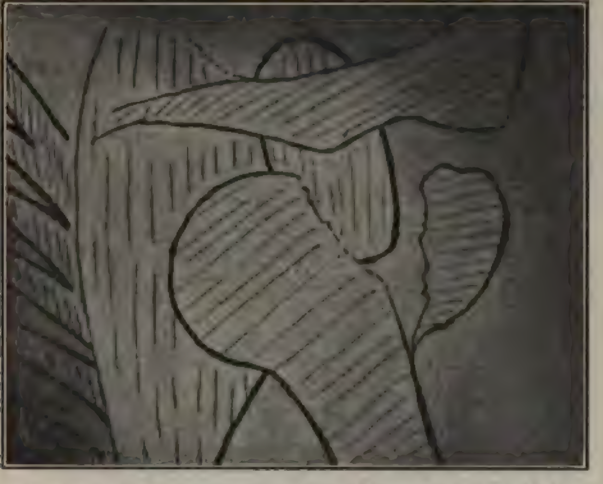


FIG. 1076.—Fracture tuberosity of humerus. (*König.*)

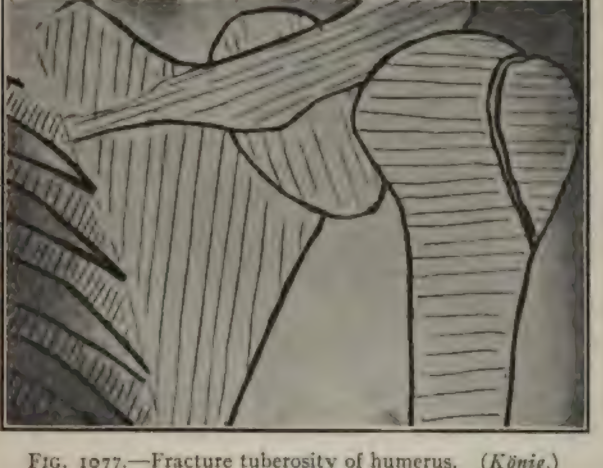


FIG. 1077.—Fracture tuberosity of humerus. (*König.*)

taking of skiagraphs *before* reduction of the dislocation (Figs. 1076 and 1077). Non-operative treatment König finds very unsatisfactory.

Methods of Operating.—(A) Fracture of surgical neck; oblique fracture through tuberosities, separation of epiphysis.

Step 1.—Make a free incision in the interval between the deltoid and pectoral. Doubly ligate or displace the cephalic vein. Penetrate between the two muscles. Retract the deltoid strongly, if necessary dividing a few fibres at its insertion. Expose the fracture.

Step 2.—Inspect the fracture. Remove interposed tissues. Reduce by traction and manipulation. If the head is dislocated, it may be necessary to bore a hole in it and insert McBurney's hook as a tractor.

Step 3.—Fasten the fragments together by means of sutures (wire, catgut, etc.), pegs, nails, staples, etc., as may be convenient.

Step 4.—Suture the torn periosteum with fine catgut. Close the wound, obliterating dead spaces.

Step 5.—Dress. Treat as a simple fracture. Begin passive motion after about two and one-half weeks.

(B) **Fracture of the Tuberosity of the Humerus.**—*Step* 1.—Exposure of the fracture.

(*a*) Cheyne and Burghard recommend that a flap containing the deltoid be turned up, the deltoid being divided near its insertion.

(*b*) Make the incision recommended for fracture of the surgical neck and by retracting the deltoid expose the tuberosity.

Step 2.—Fix the detached tuberosity in place by suture or pegs. If it is difficult to insert the peg through the incision *b*, guided by the view obtained through that incision, make a puncture through the soft parts directly over the replaced tubercle and through this insert a peg or nail.

Step 3.—Suture the torn periosteum. Close the wound. Dress. Treat as a simple fracture.

VII. **Fractures of the Lower End of Humerus.**—If the position of acute flexion (Jones's position) be adopted for all fractures of the lower end of the humerus operation will rarely be necessary. The fractures which very commonly require intervention are separation of the *capitellum humeri* and fracture of the internal epicondyle when there is much separation. The opinions of surgeons vary much as to operative interference. Cheyne and Burghard recommend operation almost as routine in T-fractures. Of course when there is grave injury to the nerves (usually the musculo-spiral and median) or to the vessels about the elbow and this is not relieved by reposition of the fragments of bone, operation is imperative.

When operating, if it is possible to avoid opening the elbow-joint, do so. Figure 1078 shows the limits of the joint. The time of choice for operation is during the second week after injury. After operation passive movements ought to be begun in about fourteen days or even less.

Methods of Operating.—(A) Fracture of one condyle.

Step 1.—Reflect a skin flap, convexity forwards, from over the fractured condyle (Cheyne and Burghard).

Step 2.—Flex the elbow. Separate the soft parts from the upper part of the condyle until there is sufficient exposure. Remove interposed tissues and wash the joint cavity with salt solution.

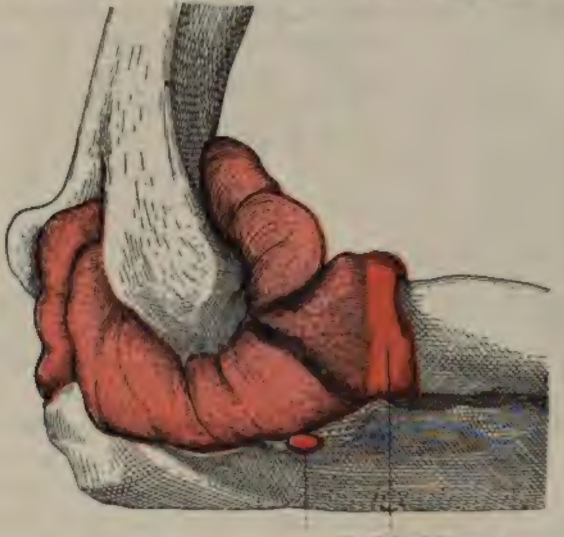
Step 3.—Reduce the fracture and fix it in position by peg, nail, or suture. Suture any important structures which may have been torn or divided.

Step 4.—Close the wound. Dress. Put up in the acutely flexed position. No splint is necessary or desirable.

(B) **Fracture of Both Condyles. T-shaped Fracture.**

Step 1.—**Method A.**—Make a longitudinal lateral incision over each condyle and expose the fracture. Do not jeopardize the nutrition of the condyle by unnecessary separation of the soft parts.

Method B.—Make a vertical median incision over the olecranon process as in excision of the elbow. Split the triceps tendon vertically. With the periosteal elevator separate the tendon from the ulna and so reach the fracture without peeling the condyle out of its attached soft parts.



Radial cul de sac.

FIG. 1078.—*(Poirier et Charpy.)*

Step 2.—Reduce the fracture. Peg the two condyles together or to the shaft of the humerus. If incision B has been used, it is well after reducing the fracture to make a puncture directly over the tip of the condyle and introduce the pegs through this puncture.

Step 3.—Close both deep and superficial wounds. Dress. Put in acutely flexed position without a splint.

Method C.—Sampson Handley thinks that the lateral incision (Method A) should always be employed, because if they suffice they do little harm, and if they do not suffice it is easy to join them by a transverse posterior cut across the olecranon, and by sawing through the olecranon to gain perfect access to the fracture.

(C) **Separation of Capitellum Humeri.**—Open the joint by an external longitudinal incision. Remove the fragment of bone. Close the wound. Dress. Begin motion within a few days.

(D) **Fracture of Internal (or External) Epicondyle.—(a)** Make a lateral longitudinal incision over the fragment of bone without opening the joint. Replace the fragment and suture it in position. The suture involves the periosteal covering or may include the cartilaginous epicondyle itself.

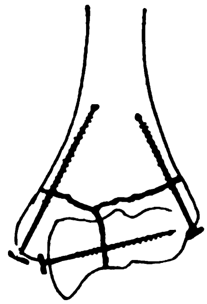


FIG. 1079.—(*Lambotte.*)

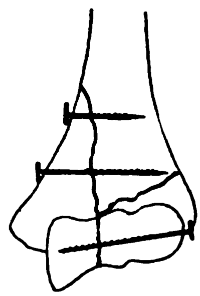


FIG. 1080.—(*Lambotte.*)

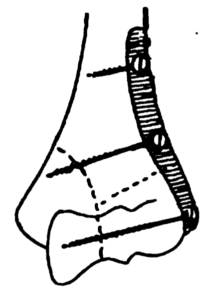


FIG 1081.—(*Lambotte.*)

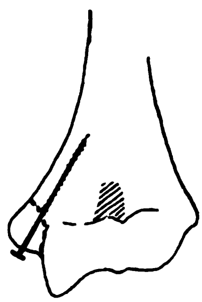


FIG. 1082.—(*Lambotte.*)

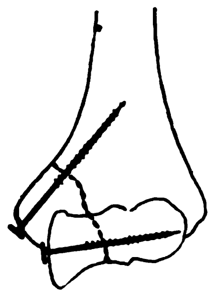


FIG. 1083.—(*Lambotte.*)

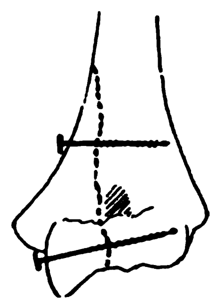


FIG. 1084.—(*Lambotte.*)

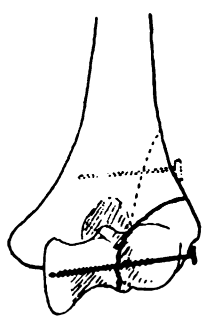


FIG. 1085.—(*Lambotte.*)

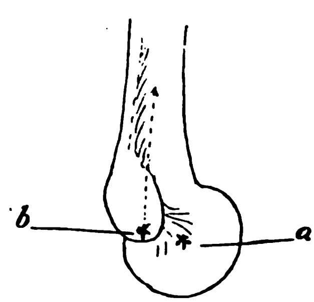


FIG. 1086.—(*Lambotte.*)
a, Point of insertion of screw into trochlea; *b*, point for nailing epitrochlea.

If the displaced fragment is very small, or if (in an old case) it has become fixed in a position which interferes with the elbow, excise it and suture the lateral ligament in proper position. Dress. Begin motion at an early date.

The following figures taken from Lambotte (L'Intervention Operatoiré dans le Fractures) show the application of screw nails to several varieties of fracture at the elbow (Figs. 1079–1086).

VIII. **Fracture of Olecranon Process.**—Most cases of the above fracture call for operation.

(A) **Subcutaneous Operation. Murphy's Method.**—*Step* 1.—Make a longitudinal incision 1/8 inch long on the outer side of ulna down to the bone, 1/2 inch from the articular surface (A, Fig. 1087). Make a corresponding but smaller incision on the inner side (B). Between these two cuts perforate the ulna and pull a wire through the drill hole. With an appropriate needle carry the wire under the skin upwards on the inner side of the elbow and draw it out through a puncture wound at the level of the tip of the olecranon (C) (the tip of the olecranon having been brought down into proper position by manipulation).

Step 2.—With an appropriate needle pass the wire through the same (upper) puncture transversely through the triceps tendon immediately above the fragment of olecranon and make it emerge through a puncture wound (D) on the outer side. Once more reintroduce the wire and make it emerge at the original incision (A). The site of fracture is now encircled by the wire.

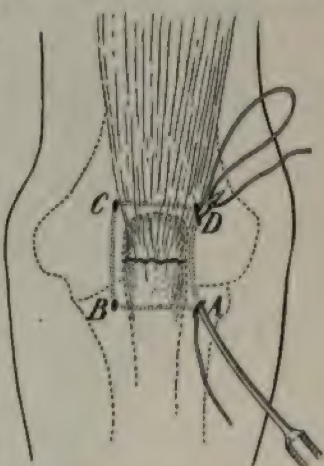


FIG. 1087.—Fracture of olecranon.

Step 3.—Tighten and twist the wire. Cut off the ends and bury the knot. Dress.

Murphy recommends immobilization in the extended position for 4 weeks, with passive motion from the third day. Cheyne and Burghard recommend that the elbow be kept at a right angle in a sling and that early motion be attempted. This advice seems very rational.

(B) **Open Operation.**

Step 1.—*Method of Exposure.*—(*a*) Make a median longitudinal incision from a point 3/4 inch above the tip of the fractured olecranon downwards to a point near the base of the olecranon. Divide the skin and superficial fascia only. Reflect the soft parts to either side until the bone covered by deep fascia, etc., is well exposed.

(*b*) Make a horseshoe-shaped incision through the skin and superficial fascia from a point just below the line of fracture on one side to a corresponding point on the other side. The cut runs upwards to a point about 1 inch above the tip of the olecranon (Fig. 1088). Reflect the flap thus outlined.

(*c*) Same as (*b*) except that the base of the flap is above instead of below.

Step 2.—Examine the fractured surfaces. Remove interposed tissues. In old cases freshen the ends of the bone. If necessary cleanse the joint cavity.

Step 3.—*Suture of the Bone.*—(*a*) With a drill make one or two oblique perforations through the upper and lower fragments at corresponding points. Pull wire through the perforations (Fig. 1089). Do *not* let the deep part of the perforation impinge upon the articular surface of the bone. While boring the holes flexion of the arm permits more easy access. Now extend the arm.

Approximate the fragments. Tighten the wire sutures and fix them by twisting. Hammer the wire knots flat or into the bone so that they may not injure the skin subsequently. Instead of wire, chromicized catgut may be used.

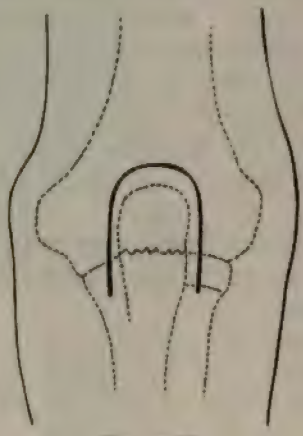


FIG. 1088.

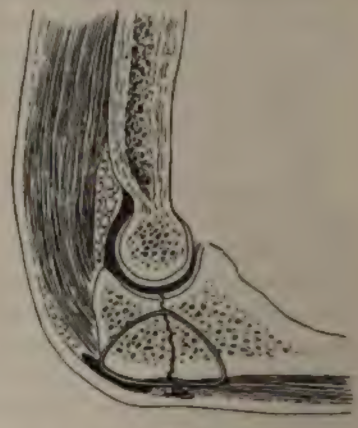


FIG. 1089.

FIGS. 1088 AND 1089.—Fracture of olecranon.

(*b*) *Circular Suture.*—With a drill make a perforation *transversely* through the olecranon about ½ inch from the fractured surface (Fig. 1090). Pull a wire through the perforation. In the same manner drill a transverse hole through the detached portion of the olecranon and pull one end of wire above

FIG. 1090.

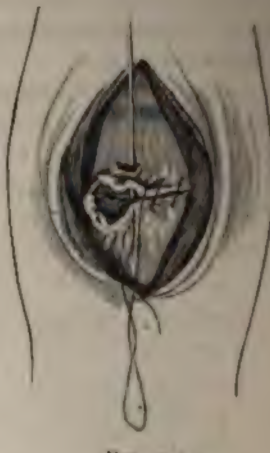


FIG. 1091.

FIGS. 1090 AND 1091.—Fracture of olecranon. (*Schwartz.*)

mentioned through it. Approximate the fragments. Tighten and fix the wire.

(*c*) Is the same as (*b*) except that the upper loop of wire perforates the triceps tendon instead of the bone. Instead of wire, chromicized catgut may be employed.

Step 4.—With fine catgut, suture the joint capsule (Fig. 1091) and the fascia covering the olecranon. Close the skin wound. Dress. The limb may be immobilized either in the extended or semiflexed position or may be put in a sling. However dressed, passive motion must be begun very early to insure good results.

Any of the methods of operating described give good results.

IX. **Fracture of Coronoid Process of Ulna.**—This fracture is rare and when present is usually associated with posterior dislocation of the elbow. As the brachialis anticus is attached near the base of the coronoid, there is

FIG. 1092.—Myositis ossificans traumatica. (*Keen.*)

not much displacement unless this part of the bone is involved. Operation must be very rarely indicated except in old cases with disability due to interference with flexion.

Step 1.—**Exposure of Coronoid Process.**—Make a lateral incision on one or each side just in front of the condyles of the humerus. With a periosteal elevator separate the muscle from the anterior surface of the condyles until the brachialis anticus and with it the coronoid process is exposed. Subsequent work is much facilitated if the process is exposed from both sides.

Step 2.—Repair whatever injury is found. Usually operation is performed *late* because of disability due to excessive callus or to the formation of bone in

the tendon of the brachialis anticus (practically myositis ossificans traumatica). When this is the case remove the excess of bone.

Step 3.—Close the wound. Dress. Apply a sling. Begin motion early.

N. B.—The above description is based on that of Cheyne and Burghard. The author has never seen a case of fracture of the coronoid process requiring operation. He has, however, seen one or more cases of myositis ossificans traumatica which perhaps might have been mistaken for such a condition, and in which the neoplastic bone was removed through an external incision penetrating the muscle (Fig. 1092).

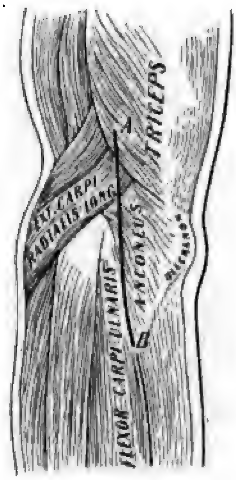


FIG. 1093.—Exposure of head of radius.

X. **Separation of Head of Radius.**—Operation is required when the head of the radius has become separated from the shaft and lies in the elbow-joint impeding motion.

Step 1.—Make a three-inch longitudinal incision as in Fig. 1093. Separate the anconeus and extensor carpi ulnaris muscles. This exposes the head of radius.

Step 2.—Incise the articular capsule. Remove the fragment of bone. Close the wound with deep and superficial sutures. Dress. Put in sling. Begin motion very early.

CHAPTER LXX

OSTEOMYELITIS

As the result of infection acute inflammation develops in the vascular spongy bone usually near an epiphysis. Pus quickly forms and, if the patient survives long enough, makes its way to the periosteum and soft parts. When the pus escapes, fistulæ are formed and persist. Early death of portions or even the whole of the bone is a prominent feature and aids in keeping up the inflammation. In time new bone is formed which incloses the dead portions (sequestra), keeps up the continuity of the bone, but prevents the escape of the sequestra when they become separated from the living bone by the activity of granulation tissue growth.

From the above it is evident that different methods must be taken to combat the disease according to the stage to which it has developed. When operating for osteomyelitis of one of the bones of an extremity, it is wise to secure a bloodless field by using an elastic constrictor, as it is very important to see clearly in order to judge how much it is necessary to do. In the succeeding paragraphs operations for osteomyelitis of the lower femoral juxta-epiphyseal bone will be taken as typical.

(A) **Early Operation.**—The patient, usually young, may have sustained a slight injury or been exposed to cold; or the patient may recently have suffered from an acute disease; there is much prostration; pain near the knee, often thought to be in the knee; there has been a chill and high fever often mistaken for typhoid; there is evidently a serious illness, often delirium is present. Locally the only symptoms may be pain and tenderness; this last is our only guide to the seat of disease. Commonly at this period there is some swelling as well as pain.

The Operation.—Before anesthetizing the patient locate the point of maximum tenderness; this is the place to be exposed by operation.

Step 1.—Make a free longitudinal incision down to the bone on the outer or inner side of the thigh as may be convenient so as to avoid injury to important structures and yet reach the point of maximum tenderness as directly as possible. The best incision is one on the outer side situated in the furrow between the biceps tendon and the ilio-tibial band (Fig. 1094). Note the condition of the divided tissues as to œdema, etc. Split the periosteum over the suspected area of bone. Note the condition of the periosteum as to thickness, softness, œdema, etc., and as to the firmness or looseness of its attachment to the bone.

Separate the periosteum from the bone over an area about ½ inch in diameter. Examine the surface of the bone for evidences of disease. Pass a grooved director round the bone to the popliteal surface of the bone as pus

from the osteomyelitis often collects here. In our example, no such evidence may be discovered.

Step 2.—With a Doyen burr (Fig. 1095), a small trephine, or a gouge and mallet, penetrate the bone to the medulla or into the spongy bone near the

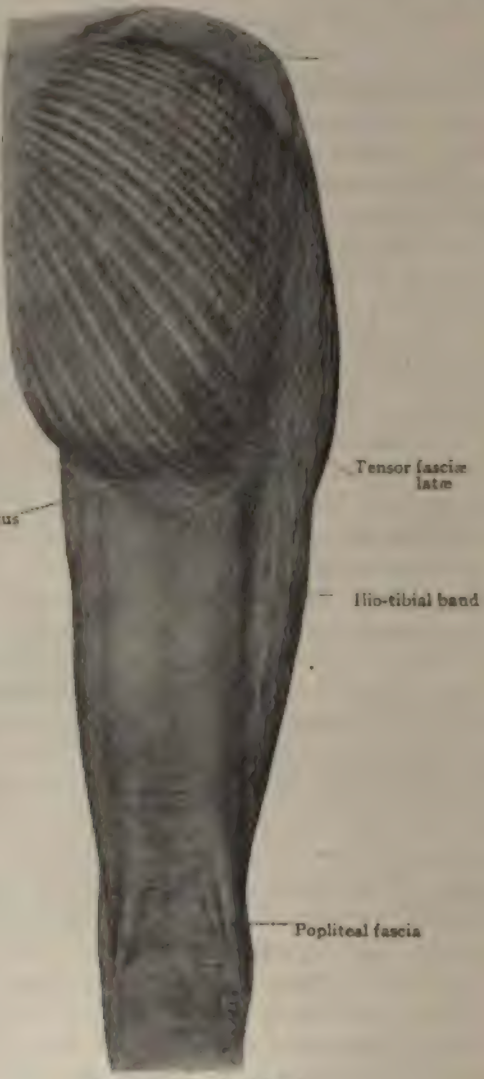


FIG. 1094.—(*Sobotta.*)

epiphyseal line (a drill or gimlet is often used to penetrate the bone, but the resulting opening is too small to permit of proper investigation). It may not be necessary to penetrate the bone very deeply as the focus of disease may be found fairly superficial. The diseased area may be recognized by its redness, the presence of granulation tissue, a decrease in the consistency

of the tissue, decrease in the amount of fat, and by the presence of a small amount of pus.

Many surgeons, especially in Paris, consider that it is not possible to distinguish clinically in all cases, acute suppurative osteomyelitis from periostitis and hence consider it harmful to systematically attack the bone since simple periosteal incision may suffice. S. Rolando ("Zentralblatt für Chir.," 1908, No. 20) has had much experience in hematogenous osteomyelitis and finds that the periostitis is always secondary to the osteomyelitis. To avoid unnecessarily extensive opening of the bone Rolando is guided by radiography and only opens the bone itself at places where clear zones indicate the presence of lesions. Rubritius ("Zentralblatt für Chir.," 1908, No. 9) thinks radiog-

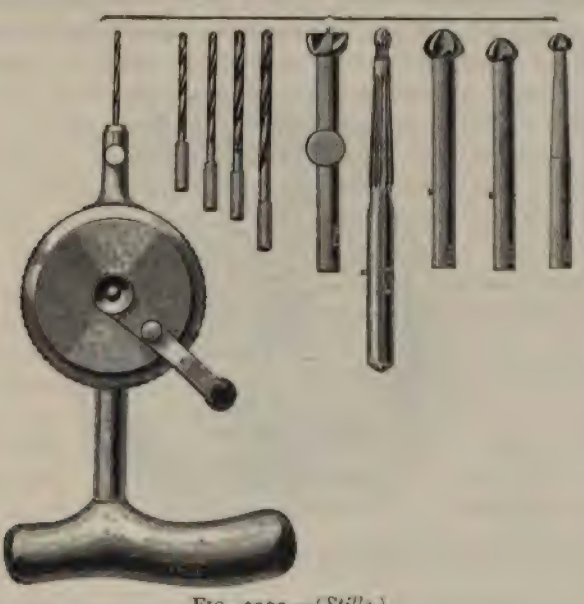


FIG. 1095.—(*Stille.*)

raphy valueless in recent cases. Multiple openings into the bone may be required. It is unnecessary to expose the whole of the medullary cavity as is done by some. All that is requisite is to penetrate the foci at the most dependent points possible, to evacuate their contents and to prevent reaccumulation.

Step 3.—Thoroughly remove all the diseased material with a sharp spoon, aided, if necessary, by a gouge. Wash or douche the cavity. Swab with Harrington's solution, with tincture of iodine, or with liquid carbolic acid, subsequently removed by swabbing with alcohol. If the original opening through the bone does not provide sufficiently free access to the disease or a proper amount of drainage, enlarge the opening with the gouge.

Step 4.—Provide for drainage by means of a rubber tube or, better, by a loose pack of iodoform gauze. Partly close the external wound with sutures.

Apply abundant dressings and a splint. During the operation as detailed, no focus of disease may be recognized. This does not by any means signify a mistaken diagnosis, it means either that operation has anticipated the gross appearances of disease or that the surgeon has failed to strike the focus. It is proper to make a further search for the focus of disease by drilling subsidiary holes in various directions. If, after this no focus is found, provide for drainage as described. If the operation has been performed before gross pathologic changes have arisen, the drainage provided may well lead to resolution taking place. If gross pathologic changes are present, but have not been discovered, it is almost certain that the pus will soon evacuate itself into the bone wound made by the surgeon.

Subperiosteal Abscess.—If in Step 1 pus is found situated under the periosteum, or if instead of pus inflammatory exudate is there present, are we

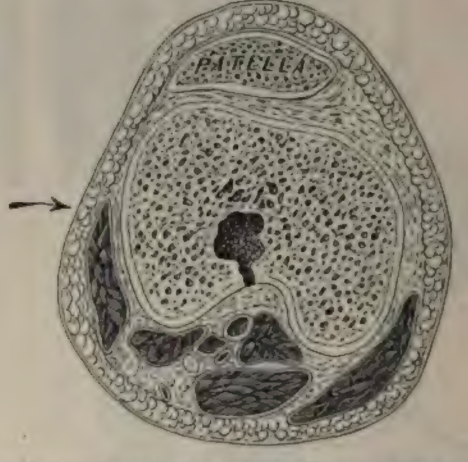


FIG. 1096.—Fistula from bone leads to popliteal space. Penetrate bone from the side.

to content ourselves with the evacuation of this focus and call the disease "periostitis"? This must be rarely necessary. Exceptionally the patient may be so weakened from absorption of toxins that the surgeon, after evacuating the subperiosteal abscess and finding, on superficial examination, no evident communication with the inside of the bone, concludes that an imperfect operation will be life-saving, while a more radical operation may be left until the drainage has permitted recovery from the more urgent symptoms. Very many cures have been obtained by this imperfect operation, but it is so uncertain, and the disease is so grave that nothing short of radical intervention is justifiable in the large majority of cases. The operation ought to be carried out on the following lines:

Expose and divide the periosteum. Evacuate the pus. Scrape away all diseased tissue. Swab with Harrington's solution or with liquid carbolic acid followed by swabbing with alcohol. Examine the exposed bone for any fistulæ or cervices through which pus escapes. If the subperiosteal pus is on

the popliteal surface of the bone, retract the soft parts and examine the bone carefully with a probe. If a fistula leads into the bone enlarge it, and follow it into the focus of disease. When the fistula opens on the popliteal surface of the bone, it is often impossible to follow it, in which case the bone must be penetrated from the side (Fig. 1096). If, after thorough cleansing of the subperiosteal abscess and painstaking examination, no disease of the surface of the bone is discovered, penetrate into the bone as in Step 2 (p. 944) and proceed as there advised.

As J. C. Warren writes, "No operation which does not include an opening into the bone should be regarded as a completed one."

When pus has broken through the periosteum and abscess of the more superficial structures is evident, the operative treatment must be carried out on the lines already described.

(B) **Abscess of Bone. Late Operation.**—The patient has survived the early and most acute phases of the osteomyelitis. No gross masses of bone have died, or if so, they have been destroyed. The neighboring bone has reacted against the inflammation and has surrounded the focus with a rampart of thickened and sclerosed bone through which fistulæ lead to the skin. Drainage is imperfect, but the main impediment to recovery consists in the sclerosed bone which will neither provide healthy granulation tissue to obliterate the abscess cavity, nor permit its walls to collapse. The objects of operation are (*a*) to cleanse the abscess cavity thoroughly; (*b*) to obliterate it.

These objects may be attained in more than one way.

Method A.—*Step* 1.—After applying the elastic constrictor, expose the bone freely by a suitable incision as in an acute case.

Step 2.—With a gouge and mallet expose the abscess cavity freely and clean it *thoroughly*. Dissect away the diseased lining of all fistulæ. Thoroughly disinfect as in acute cases. After the thorough cleansing, temporarily pack the wound with gauze; clean the skin around the wound; replace all soiled towels by clean ones; discard all instruments which have been in contact with the wound up to this time; let the surgeon and assistant clean their hands or change their gloves. It is important to act as if the completion of Step 2 was the completion of the operation, the further steps being considered as a new operation performed on a clean patient, with all the appliances fresh and clean.

Step 3.—Remove the pack from the wound. With gouge and mallet cut away the sclerosed bone from around the site of the abscess, until healthy bone is reached. The object of this is to leave the cavity lined with bone from which it is reasonable to suppose that healthy granulation tissue will grow and obliterate it. The removal of the sclerosed bone is entirely analogous to the removal of scar tissue from around a vesico-vaginal fistula before closing it with sutures.

Step 4.—Loosely pack the cavity with iodoform gauze. Apply liberal dressings. If necessary, apply a splint. Put the patient in bed with the limb elevated. Remove the elastic constrictor. The author often fills the

cavity with a powder consisting of iodoform 1, crystalline boracic acid 4, instead of employing gauze packing.

The subsequent treatment consists in keeping the wound clean and encouraging the formation of granulation tissue. Remember that the open air, good food, good company and good amusements are the best tonics and that the patient requires such.

Methods B.—Use of Bone Plugs. Mosetig-Moorhof's Method ("Zent. für Chir.," April 18, 1903).

Steps 1, 2, 3, as in Method A. To remove any blood-clots adhering closely to the bone, Mosetig uses peroxide of hydrogen. After every particle of bone even suspected of disease has been removed and with it thes clerosed bone, the cavity must be thoroughly dried. For this purpose a douche of hot air is most valuable. The simplest hot-air douche is shown in Fig. 1097. The cavity is now ready to be filled.

Delbet, to test the above method, cleaned osteomyelitic cavities carefully, insufflated with hot air, curretted and then made cultures from particles re-

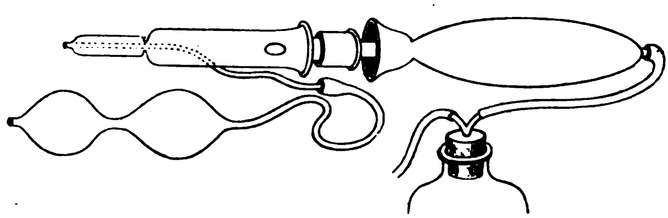


FIG. 1097.—Hot-air douche.

moved. The cultures were always positive. If he used tincture of iodine instead of hot air the cultures were negative. The hot air used had a temperature of 200°–300° but the temperature of the bone was little raised by it. Quénu is disappointed with hot-air disinfection and doubts the efficacy of tincture of iodine. Sebileau thinks the virtue of hot air consists in drying the cavity and so in permitting the adhesion of any antiseptic material to its wall. Dentists are well aware that they do not sterilize pulp cavities by using hot air but merely dry them ("Surg. Soc.," Paris, Dec. 11, 1911).

Step 4.—The following prescription has been prepared before-hand: Iodoform, 60 parts; spermaceti, 40 parts; oil of sesame, 40 parts. Heat slowly to 100° C. When the mass cools it forms a soft solid at the body temperature. Immediately before use heat the iodoform mixture in a water-bath to 60° C. to render it fluid. Pour it into the bone cavity very slowly so as to avoid the formation of air-bubbles. Fill the bone cavity completely. As soon as the mass solidifies, replace and suture the periosteum and soft parts in position. If one or more fistulæ are present, these act as drains; if such are absent, spaces between the sutures, or a strip of rubber tissue will serve the purpose. Before suturing, ligate any divided vessels which may be visible. Apply dressings and if necessary a splint.*

* A splint is required if one wishes to immobilize a neighboring joint or if, as is sometimes the case, a mere shell of bone is left full of the iodoform wax plug.

Put the patient in bed with the limb elevated and only then remove the elastic constrictor. The iodoform wax plug fills the cavity until such time as granulation tissue and ultimately bone penetrates and replaces it. Elsberg, using Mosetig's plug, has modified the method of application as follows: Remove the elastic constrictor before pouring in the plug. Gain the necessary dryness by applying adrenalin gauze. Permit the iodoform wax to partially harden outside the body and then with the fingers press bits of it into the walls of the cavity until the whole space is filled in the manner a dentist fills a cavity in a tooth.

To the writer Elsberg's modifications do not seem to be improvements.

Method C.—Is the same as Method A except that in Step 3 so much bone is removed that the soft parts can readily come into contact with the whole of the wall of the cavity left. The particulars of this method will be more fully described under Necrotomy. Various plastic operations devised to fill bone cavities will be found described elsewhere.

(C) Osteomyelitis accompanied by death of bone. Methods of operating.

Sequestrotomy. Necrotomy.—The indications for operation vary with the acuteness of the disease and with its extent. When the disease does not affect the whole thickness of the bone and the sequestrum is of but moderate size, no matter whether the disease be acute or chronic, no surgeon would hesitate to do a radical operation and do it promptly. When the disease is very acute immediate operation is imperative to prevent death from sepsis, but if the whole thickness or length of the bone is necrosed differences of opinion are permissible as to the extent of the operation. If under the above circumstances the dead bone is found separated from the living bone, in case the whole bone is affected, it is separated from the surrounding tissues, no good but rather much evil may be expected from its retention, hence it must be removed. If, however, the dead bone is not entirely free it is often the best practice to drain away all the products of inflammation but leave the sequestrum *in situ* to act as a splint until new bone has been formed sufficient in quantity to preserve continuity. Should the irritation from the presence of the dead bone keep up so much inflammation as to endanger life, or should its presence interfere with proper drainage, then it must be removed. In almost all subacute and chronic cases of extensive necrosis, it is possible and wise to delay removal of the sequestrum until sufficient new bone has been formed to maintain continuity. During this period of waiting efficient drainage must of course be provided.

In the succeeding paragraphs operations on the tibia will be generally taken as typical.

(*a*) The extent of necrosis is not great. Operate exactly as for acute or chronic abscess of the bone, removing sequestra—if loose, with forceps; if fixed, with the chisel.

(*b*) The necrosis is extensive as regards length, but enough healthy bone remains or enough involucrum has been formed to insure the continuity of the bone. The old method of treating this class of cases was to enlarge one

of the fistulæ leading through the involucrum and through this to extract the sequestrum in one or more fragments, provided it was loose; if the sequestrum was found still attached to the living bone, operation was given up until separation was complete. Such a procedure gives no opportunity to clean the dirty cavity which contained the bone and has been entirely discarded.

Typical Sequestrotomy.—*Step* 1.—Make a longitudinal incision down to the bone throughout the whole length of the disease. This incision may pass through the mouths of one or more fistulæ or may be independent of such. Denude the bone of periosteum for about ½ inch on each side of the longitudinal incision. Retract the soft parts.

Step 2.—If the sequestrum is entirely superficial remove it. If, as is the rule, the sequestrum lies inside a coffin (involucrum) of new bone, perforated by fistulæ, proceed as follows: With chisel and mallet remove enough of the new bone to give access to the whole of the sequestrum and to every part of the cavity in which it lies. Remove the sequestrum, if necessary cutting it from the living bone with the chisel or other appropriate instrument.

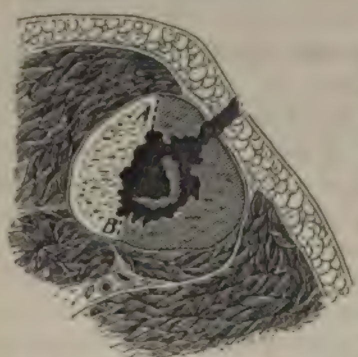


FIG. 1098.—Sequestrotomy.
The bone is divided at A and B and the shaded area removed.

In removing a portion of the involucrum to expose the dead bone, if possible, do so in such a manner that the whole of one wall of the cavity is removed, the whole of the other side or wall being retained, thus after the sequestrum is taken away and the cavity cleansed the overlying soft parts may naturally fall into and obliterate the cavity (Fig. 1098).

After removing the dead and infected portions of the bone there may be a mere splint of sound bone (cortical bone) left maintaining continuity. This is quite sufficient as it will thicken and grow rapidly. As the extensive removal of bone has completely done away with the bone cavity, the soft parts can be brought together and healing by first intention sought. Several different methods of attacking the bone with a view to obliterating the cavity will be described later.

While working on the bone be careful to avoid fracturing that portion of the involucrum which is to be retained and on which the continuity of structure depends.

Step 3.—With the curette, aided if necessary by the gouge, remove all diseased granulation tissue and bone from the inside of the involucrum and from any existing fistulæ. Swab the cavity with Harrington's solution or with liquid carbolic acid (95 per cent.) subsequently swabbing with alcohol. Ochsner follows this by applying tincture of iodine. If there is any doubt as to the complete removal of all infected tissue, pack the cavity with iodoform gauze and if the wound is found aseptic, after a few days close it with sutures. If it is

believed that all disease has been removed the wound may be closed at once, any non-obliterated cavities being drained, or the cavity may be filled with Mosetig-Moorhof iodoform and wax plug. The author has had very satisfactory result from filling the cavity with a powder consisting of iodoform 1, boracic acid (in crystals) 4. Even when the cavity was not above suspicion in regard to cleanliness rapid healing has ensued. After dressings are applied fix the limb in a splint. Regeneration of the bone is usually rapid.

Methods of Obliterating the Bone Cavity after Sequestrotomy.—It is assumed that the sequestrum and all diseased tissue have been completely removed, that the cavity has been disinfected and packed with gauze, that the skin around the wound has been prepared as if for a new aseptic operation, that the surgeon and assistants have prepared themselves and the instruments as if for a fresh operation.

I. **Schede's Aseptic Blood-clot.**—Remove the pack of gauze from the bone cavity. Unite the divided periosteum and soft parts with fine buried sutures in layers. Close the skin wound. Provide drainage by a few strands of catgut, a chicken-bone tube or a strip of rubber tissue. Apply abundant dressings. Immobilize the limb in an almost vertical position. Remove the elastic constrictor. Enough bleeding takes place to fill the cavity with blood. Any excess of blood is carried into the dressings. The elevated posture prevents all dangerous or inconvenient hemorrhage and may be safely discontinued after twelve to twenty-four hours. If everything progresses favorably a large cavity may heal under one dressing in about six weeks. Keep a very sharp watch for signs or symptoms of decomposition in the wound as this is liable to occur and necessitates immediate evacuation and drainage.

II. **Senn's Decalcified Bone Chips. Preparation of the Chips.**

"Select the compact layer of the fresh tibia of the ox, remove all periosteum and medullary tissue, divide into longitudinal strips about ⅛ of an inch wide and immerse in a relatively large quantity of 10 to 15 per cent. watery solution of hydrochloric acid which must be renewed daily, for from one to two weeks; then wash thoroughly in water or a weak solution of caustic potash, cut into small chips, soak for forty-eight hours in 1:1000 mercuric bichloride solution, remove and store in a saturated solution of iodoform in ether. When about to be used, wrap in aseptic gauze, dissolve out the excess of ether and iodoform with alcohol and put in 1:2000 mercuric bichloride solution until required, when careful drying with iodoform gauze should precede their implantation." (Senn.)

Remove the gauze pack from the bone cavity. Fill the cavity completely with the decalcified bone chips. Treat exactly as in Schede's method. The interstices between the chips become filled with blood. The bone chips, it is claimed, strengthen the frame-work of blood-clot into which the healthy granulation tissue penetrates, while being impregnated with iodoform they keep that drug disseminated throughout the blood-clot where it inhibits bacterial activity.

Instead of decalcified chips such foreign material as plaster of Paris, amalgam and chips of fresh bone have been used with occasional success. Neuber believes the whole value of Senn's bone chips lies in the fact that they keep

iodoform diffused through the blood-clot, but that the bone chips themselves are objectionable as they are too slowly absorbed. Iodoform glycerine is valueless as a substitute because the iodoform in it is quickly precipitated. Neuber's method is as follows:

III. **Neuber's Iodoform Starch.**—Preparation of the starch. Mix 10 grams of wheat starch with the smallest possible amount of water in an open glass vessel, pour into this, constantly stirring the mixture, 200 grams of boiling 2 per cent. watery carbolic solution. After partial cooling, stir in 10 grams of powdered iodoform. Pour into a sterile glass flask. This mixture may be kept for weeks in a dark room. It is used in the same fashion as Mosetig-Moorhof's iodoform wax. Neuber considers this method suitable: (a) after superficial sequestrotomies and the removal of superficial tuberculous foci; (b) after sequestrotomies when the bone cavity is deep and large but its edges are uniform and sloping (not overhanging).

IV. Mosetig-Moorhof's iodoform wax plug has already been described.

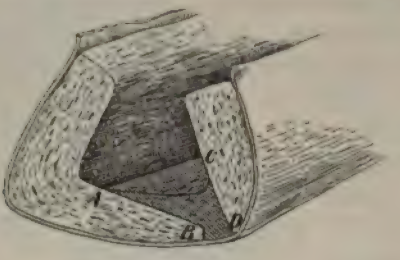


FIG. 1099.

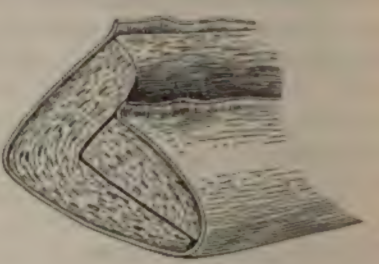


FIG. 1100.

V. Emil Beck's bismuth paste ("Journal A. M. A.," March, 14, 1908) may be used in a manner similar to Neuber's starch. The formula of the paste is as follows:

Bismuth subnitrate	30.0 grams.	(Carbonate?)
White wax	5.0 grams.	
Soft paraffin	5.0 grams.	
Vaseline	60.0 grams.	

Mix while boiling. Do not spill any water into the paste while boiling. If a syringe is used to insert the paste it should be sterilized by the dry process and the plunger dipped in sterile vaseline instead of water. Soft paraffin differs from hard paraffin in being absorbable. Occasionally Beck adds 1 per cent. of formalin to the paste.

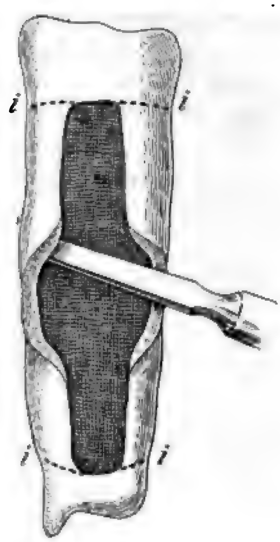
As a number of cases of nitrite poisoning, some fatal, have been observed after the use of subnitrate of bismuth, it is recommended that the carbonate of bismuth be used in place of the subnitrate.

VI. The cavity left after removal of the sequestrum has walls which prevent obliteration by the falling in of the overlying soft parts. With the chisel cut through the bone at the base of one of the walls for the whole length of the cavity, but carefully avoid cutting the periosteum. Remove a wedge-shaped

strip of bone A B C D along this line of section to permit the mobilized bone to fall in and obliterate the cavity (Figs. 1099 and 1100).

VII. **Osteoplastic method of M. W. af Schultén** ("Archiv für klin. Chir.," 145). Of this method there are several varieties, in all of these the anterior of the bone cavity (of the tibia) is removed, sequestra, etc., extracted, the y disinfected and packed with gauze for about three weeks or until it is ed with healthy granulation tissue. After being packed with gauze ound should be partly closed with sutures to prevent too much retraction soft parts.

riety a of Method (the whole shaft of the tibia is affected).—*Step* 1.—letely remove the two lateral walls of the bone cavity in its middle third 1101), leaving the posterior wall to maintain continuity.



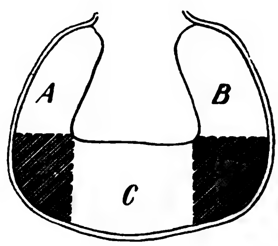


FIG. 1102.

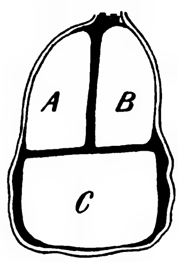


FIG. 1101. FIG. 1103.

FIGS. 1101, 1102 AND 1103.—Sequestrotomy.

Step 2.—At the upper and lower ends of the primary incision (made in the revious operation and now reopened) make transverse incisions down to the one (Fig. 1101, i, i). Through these cuts divide the lateral walls of the cavity ransversely.

Step 3.—Introduce a chisel into the bone cavity through the anterior openng made at the first operation and cut through the junction of the lateral valls (A, B, Fig. 1102) with the posterior wall (C, Fig. 1102) of the cavity. *Be areful to leave the periosteum intact.*

Step 4.—From the edge of the posterior wall (C) of the cavity or the bases f the lateral walls shave away enough bone to permit the lateral walls to lide together (Fig. 1102).

Step 5.—Approximate the lateral walls (Figs. 1102–1103 A, B) and fix them

by periosteal or bone sutures as may be convenient. Close the wound in the soft parts. Dress and apply a splint.

N. B.—The object in treating the upper and lower thirds of the bone differently from the middle third is that the portions of the cavity situated at the ends of the bone are more difficult to obliterate by the falling in of the soft parts than is that part in the middle of the shaft.

Variety b of Method.—Divide the lateral walls of the cavity transversely at both its extremities and also at its middle (Fig. 1104). Mobilize and approximate the lateral walls as in variety a. Here the whole cavity is obliterated in the method used in the previous operation for the upper and lower ends. Mobilization of each lateral wall in two segments is more easily accomplished than in one, hence the transverse incision in the middle.

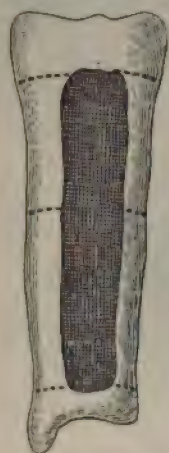


FIG. 1104.—Sequestrotomy.

VIII. **Neuber's Method of Invagination.**—Sequestrotomy has been performed, the wound has been disinfected, and all sclerosed connective tissue has been dissected away. With the chisel remove most of the lateral walls of the bone cavity, but preserve the periosteum unless it is infected. Invaginate the overlying soft parts and fix them in position by suture, pegs, or strapping. Figures 1105, 1106, 1107 explain the method more clearly than words.

IX. M. W. af Schultén's method for obliteration of cavities in lower end of femur.

Cavities at the lower end of the femur are not so amenable to the ordinary means of obliteration as are those in the tibia or the shaft of the femur. Af Schultén ("Archiv für klin. Chir.," liv, 328) advises filling the cavity with a flap of muscle and periosteum. The operation is done in two stages.

Stage 1.—This is the same as for old abscess plus sequestrotomy and need not be described again.

Stage 2.—This is undertaken two to three weeks after Stage 1. Apply an elastic constrictor.

Step 1.—With the sharp spoon remove all the granulation tissue from the wound and the bone cavity. Disinfect the cavity as thoroughly as possible. Pack the cavity temporarily.

Step 2.—Supplement the primary longitudinal incision by a transverse one involving the skin alone. Reflect the skin as in Fig. 1108, exposing the deep fascia.

Step 3.—Make the flap A B C (Figs. 1108 and 1109), consisting of deep fascia, muscle, and periosteum and having its pedicle above. The flap must be long enough and so located that it will easily fall into the bone cavity after being mobilized (Fig. 1110). (In mobilizing the flap it may perhaps be well to use a chisel instead of an elevator and so leave a thin shell of bone or some fragments of bone attached to the periosteum.) If the shape of the upper end

of the bone cavity interferes with the pedicle of the flap when it is implanted into the cavity, trim the bone with the chisel until the fault is eliminated.

Step 4.—Remove the elastic constrictor. Attend to hemostasis. Remove the temporary pack from the bone cavity. Fill the cavity with the mobilized flap (Fig. 1110). Fix the flap with a few catgut sutures. Close the skin

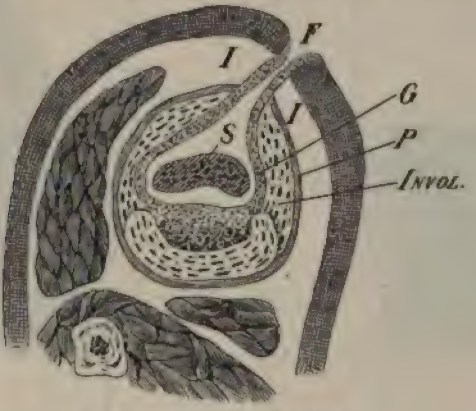


FIG. 1105.—Sequestrotomy.

(Fig. 1111) wound with or without drainage. Apply dressings and a splint. Keep the limb elevated for twenty-four hours.

Af Schultén considers that any pressure exerted upon the wound may interfere with the vitality of the transplanted flap, hence he coveres the area of the wound with a wire cage over which he lays a few layers of gauze. By this means no dressings touch the wound area which is protected completely

FIG. 1106.

FIG. 1107.

FIGS. 1106 AND 1107.—Sequestrotomy.

from all irritation by the gauze covering the wire cage. The author uses a similar method for the protection of areas covered with Thiersch's skin graft and finds it excellent. He surrounds the area with a cushion of sterile gauze or cotton, like a bird's nest or ring cushion and covers the hole in the centre of the cushion with a few layers of gauze. This përmitsa evporation of dis-

charges and at the same time keeps away irritation. When the bone cav is very deep, two muscle and periosteal flaps may be used one above the otl (Figs. 1112, 1113).

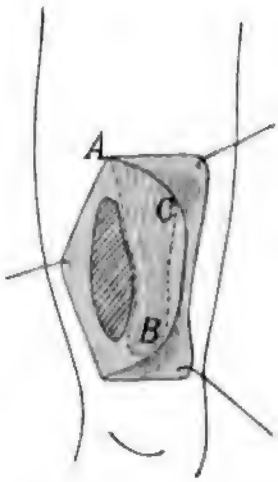


FIG. 1108.—(*Af Schultén.*)

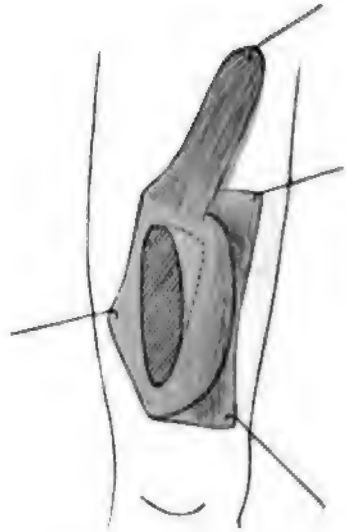


FIG. 1109.—(*Af Schultén.*)

When the bone cavity is very long, two flaps may be used as shown i Figs. 1114, 1115. Similar procedures may be applied to the obliteration o cavities in other locations.

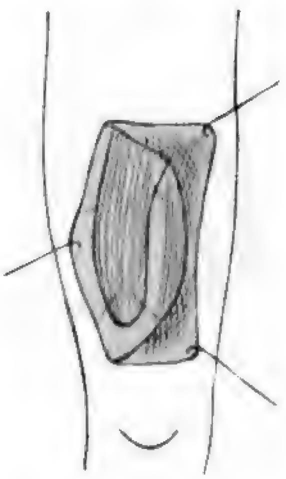


FIG. 1110.—(*Af Schultén.*)

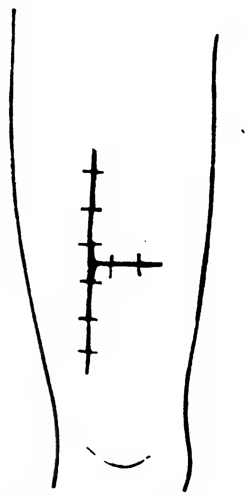


FIG. 1111.—(*Af Schultén.*)

(*c*) The whole or almost the whole shaft of the bone is necrosed, the perios teum is almost entirely separated from the bone and between these two struc tures there is much pus.

As already mentioned, if efficient drainage can be maintained, it is wise to :ain the sequestrum as a splint, especially as many cases are known in which .rtial regeneration of the apparently dead bone has taken place. If, however, spite of free drainage symptoms of intoxication persist the dead bone must be moved. If a disk of healthy bone is left between the shaft and epiphysis

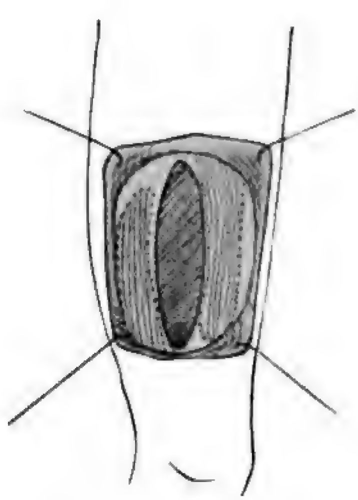


FIG. 1112.—(*Af Schultén.*)

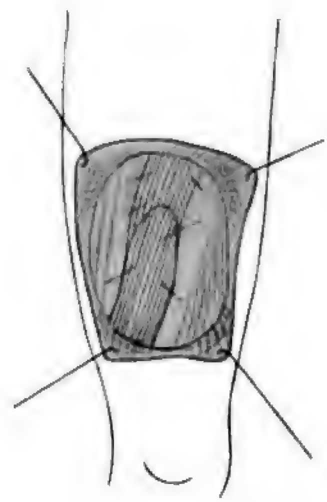


FIG. 1113.—(*Af Schultén.*)

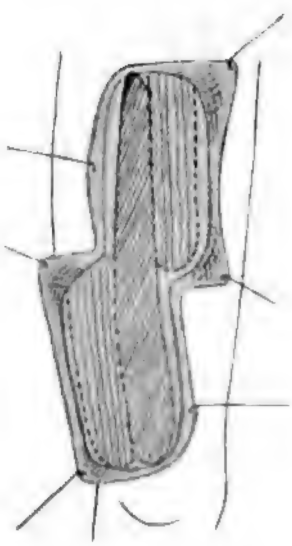


FIG. 1114.—(*Af Schultén.*)

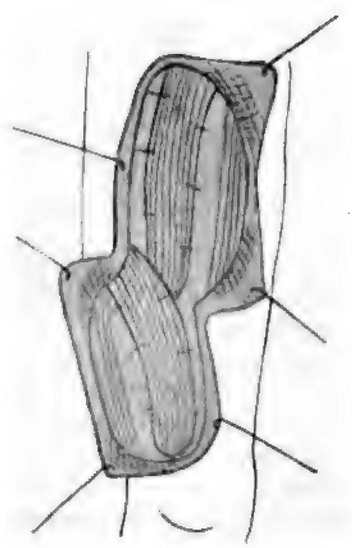


FIG. 1115.—(*Af Schultén.*)

deformity from shortening need be anticipated (G. B. Johnston). When the ia, for example, is removed its companion bone, the fibula, takes on com- ısatory hypertrophy. G. Ben Johnston ("Transactions Am. Surg. Assoc.," i) thus describes the operation:

"(*a*) Free incision and complete removal of *all* diseased bone.

"(*b*) Spare all periosteum possible.

"(*c*) Avoid curette, or use cautiously.

"(*d*) Purify the wound by the strictest antiseptic methods.

"**After-treatment.**—(*a*) Maintain aseptic methods.

"(*b*) Avoid too frequent and rough dressings.

"(*c*) Treat as a fracture by immobilization in a fracture box.

"(*d*) Carefully shape the parts, as bone tissue develops, by bandages or adhesive straps.

"(*e*) Protect the young bone by means of plaster of Paris.

"(*f*) Abstain from the use of the limb until the new bone is capable of sustaining the weight of the body.

"(*g*) Look after the general health."

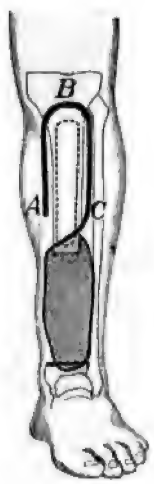


FIG. 1116.—(*v. Eiselsberg.*)

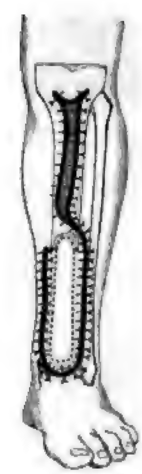


FIG. 1117.—(*v. Eiselsberg.*)

Le Conte ("Trans. Am. Surg. Assoc.") takes up a very similar position supporting it by the experience of himself and his colleagues in the Pennsylvania Hospital of Philadelphia.

X. Von Eiselsberg's method. Treatment of large defects in tibia. Von Eiselsberg ("Archiv für klin. Chir.," lv, 435) extended the König-Müller method of closing cranial defects to the treatment of large defects in the tibia. While the method was devised to repair the damage done by the removal of a sarcoma, it may be employed to rectify defects from other causes, *e.g.*, from total necrosis of a long segment of the bone.

Step 1.—Apply an elastic constrictor. Clean and vivify the defect to be filled. If very little of the lower end of the tibia remains it may be removed and a portion of the astragalus vivified for the reception of the flap.

Step 2.—Divide the skin so as to make the flap A B C, Fig. 1116. With a chisel make an incision through the whole thickness of the cortical bone along the dotted line in Fig. 1116. *Do not in any way* separate the soft parts

from the bone within the encircling bone incision. With the chisel separate the divided cortical bone, in one piece with the periosteum and skin, from the medullary bone. This gives us a flap of skin, periosteum, and cortical bone provided with a pedicle at A.

Step 3.—Twist the flap into position to fill the tibial defect (Fig. 1117). Suture it in position. Do *not* apply too much torsion to the pedicle, and when applying dressings do not let them exert much pressure either on the pedicle or on the flap.

Step 4.—Close the wound left on the upper part of the leg by sliding the skin over the osseous wound. Complete closure will often be impossible, but the resultant space may be subsequently covered by Thiersch's skin grafts.

Step 5.—Apply dressings and a splint. Place the limb in a vertical position. Remove the elastic constrictor.

CHAPTER LXXI

TUMORS OF BONE

I. **Benign.**—Removal of the neoplasm itself is usually all that is necessary for a cure. If the tumor involves so much bone that, after its removal, restoration of the continuity of the limb becomes impossible or inadvisable, then amputation may be necessary.

Simple cysts of the long bones have no connective tissue capsule, but islands of cartilage may exist in the bony capsule. They should merely be curetted and drained. R. C. Elmslie (Brit. Journ Surg., II, No. 5), speaking of benign cysts (osteitis fibrosa) of the humerus, advocates thorough curettement, and opening of the medullary cavity above and below so as to admit normal marrow into the cavity. "If there is any deformity, the humerus may be safely broken or cut through at the site of the cyst in order that the bone may be straightened." Ordinary dentigerous cysts merely require evacuation of their contents, removal of their membranous lining and excision of just so much of their bony wall as will correct deformity. Adamantine epitheliomata (Bloodgood) differ from dentigerous cysts in containing white granular tissue. Such a tumor must be excised *with* its bony wall, but it is permissible to keep close to the tumor. This tumor is included among the benign neoplasms merely because it is indistinguishable clinically from a dentigerous cyst and if excised as above it does not tend to recur. Osteomata should be removed thoroughly along with considerable of their bony basis. The same is true regarding enchondromata.

II. **Tumors of a Low Grade of Malignancy.**—Many of the tumors referred to can scarcely be recognized before being exposed or incised.

Giant-cell Sarcoma. Myelogenous Sarcoma. Myeloid Sarcoma.—When cut into, the tumor presents a peculiar brownish-red color like liver or spleen. It is very vascular, hemorrhage into it is common, it is friable and can be broken up into irregular masses. The tumor usually grows in the medullary cavity of the long bones and is surrounded by a shell of new-formed bone. It is only locally malignant, in its earlier stages at least, and generally grows slowly without much pain, causing a gradual and uniform expansion of the bone. In time the tumor extends beyond the bone and invades the soft parts and must then be considered distinctly malignant.

In its early stages a giant-cell sarcoma may be treated by excision of the tumor and the surrounding bone. W. Kramer writes ("Archiv für klin. Chir.," lxvi): "It is only during the operation that the surgeon can come to a conclusion as to the propriety of conservatism. In my two cases I have not been afraid to ascertain the condition of the marrow by an exploratory

evidement of the remaining bone and have only proceeded to unite the ends of the bone when that has been found normal." J. C. Bloodgood ("Journal A. M. A.," Feb. 1, 1908) writes of giant-cell sarcoma: "It may be as slow of growth as the cyst. The X-ray shadow does not distinguish it positively from any other medullary tumor having a bone shell. This tumor has been permanently cured by simple curetting. Recurrences have followed curetting, but were permanently eradicated by a second operation of curetting resection, or amputation. Of over one hundred cases of the pure tumor none has given metastasis. It seems justifiable at the first operation, therefore, to attempt the most conservative method, even with the risk of a local recurrence which, if it does occur, apparently is not associated with any danger of metastasis. One should not attempt curetting unless there is a thick shell of bone, so that the curette or chisel removes a zone of bone beyond the tumor. When the shell of bone is thin, subperiosteal resection should be performed; when the periosteum and surrounding muscles have become infiltrated, total resection is indicated. In one of my recorded cases in which a cure was effected and in which there was infiltrated muscle, the microscope demonstrated the giant-cell tumor within a few millimetres of the plane of resection. For the periosteal giant-cell tumor local resection with chiseling of a zone of bone beneath is sufficient."

O. Hildebrandt believes the local removal of myeloid sarcomata gives uncertain results and is not advisable.

Sir H. Morris removed the radius and ulna for a myeloid sarcoma originating in the former and firmly attaching the ulna to it. After four years there was no recurrence. Clutton operated on three cases of endosteal sarcoma of the radius. In one of these the sawed end of the bone showed a small nodule of tumor in the medullary canal; after this was removed by scraping and gouging a cure seems to have been obtained. In another case where the head, neck, and upper end of the radius was excised there was no recurrence when the patient died from renal disease after eighteen months.

Herten ("Zentralblatt für Chir.," Feb. 5, 1910) reviews the cases (60 in all) of sarcoma of the long bones operated upon in the Breslau clinic between 1890 and 1909.

Amputation or exarticulation were performed in advanced cases when the sarcoma did not seem suited for resection. (Twenty cases of periosteal sarcoma; six of myelogenous, central and chondro-sarcomata.)

None of the periosteal sarcomata were permanently cured while there was no recurrence in two cases of myelogenous sarcoma, in one of central round cell sarcoma, and in one of unknown variety. Of twenty-nine resections five were too recent for consideration; of the remaining twenty-four, twelve were periosteal, twelve myelogenous, central and chondro-sarcomata. One of the periosteal remained cured, *but only after* amputation because of poor nutrition of the limb and reamputation because of recurrence one year later. In the group of myelogenous and central sarcomata nine were cured and three died.

Among the nine which remained well, four required amputation subsequently, but in five the resection sufficed.

Among the twenty-nine resections, recurrence was recognizable eight times and in eight cases amputation or exarticulation was necessitated owing to recurrence or to want of consolidation.

Herten concludes that a high amputation or exarticulation is always indicated in periosteal sarcoma of the long bones, while in myelogenous, central and chondro-sarcoma resection is proper in favorable cases. In one case where a central round cell sarcoma of the humerus was resected there was no recurrence until after the lapse of five years when "suddenly within six weeks there was a recurrence the size of a head."

Küttner disapproves of conservative operations in periosteal sarcomata, prefers amputation even in myelogenous sarcoma and thinks resection only justifiable in very favorable cases.

On the whole, one may conclude that a conservative operation is proper for the thorough excision of giant-cell tumors affecting bones which are of prime importance for the efficiency and comfort of the patient. Examples of such bones are the femur, the humerus, the radius or ulna, the jaws, etc. When a toe, finger, foot, or perhaps even when the tibia is the site of the disease, amputation may leave the patient as capable or more capable of pursuing work or pleasure and gives a better assurance of real cure. The amputation ought, however, to be conservative and not such as is described later in this chapter.

Pure myxomata of bone (endosteal or periosteal) are rare. Treatment is the same as for giant-cell sarcomata.

III. **Malignant Tumors.**—Sarcomata (round or spindle cell, angio-sarcoma) are the malignant neoplasms which occur primarily in bone. These tumors (whether central or subperiosteal) early pass beyond the limits of the bones and infiltrate the muscles and tendons attached to them. The muscles act as an excellent path for the conduction of the infiltrating neoplastic tissue from one bone to another, *e.g.*, the deltoid may conduct neoplastic tissue from the humerus to the scapula. This is important from the standpoint of treatment. Metastasis is very common in spite of treatment. A classical rule in the treatment of sarcoma of bone was to amputate at or above the joint proximal to the disease, *i.e.*, to remove the whole of the bone affected. This treatment ought to be effective if the tumor is still confined within the bone; if, however, muscular infiltration has taken place, even if it is not apparent to the naked eye, then the only hope of benefit lies in more extensive work. *Theoretically* to achieve the best permanent results one should remove the bone primarily diseased, the muscles inserted into it and the bones from which these muscles arise. This theoretical aim is nearly attained in the cases of tumors of the humerus by interscapulo-thoracic amputation. The accompanying statistics speak for themselves.

Berger. Forty-six cases. Primary mortality, 5 per cent. Free from recurrence after one year, 33 per cent.

Könitzer. Primary mortality, 4 per cent. Known recurrence, 21 per cent. Free from recurrence in less than one year, 34 per cent. Free from recurrence longer than one year, 21 per cent. Untraced, 24 per cent.

The same principle may be easily carried out in sarcomata of the foot by amputating above the knee. Unfortunately, in many or most instances practical considerations (primary danger, unendurable deformity, etc.) prevent the attainment of the ideal. Under these circumstances one may amputate as high as possible and at the same time remove as thoroughly as possible the muscles inserted into the diseased bone, especially those most likely to be involved. *Example:* Periosteal sarcoma on the *outer* side of the head of the tibia. Amputation above the knee is necessary. It is probable that any neoplastic invasion of the tendo patellæ will be slow to spread upwards *beyond* the patella; hence if the disease is tolerably recent the quadriceps extensor may be considered reasonably safe. The biceps is the muscle most probably involved, hence as soon as the amputation is completed and the main vessels ligated it seems to the writer most reasonable to expose this muscle throughout its whole length and to excise it completely.

Carcinomata and hypernephromata are always secondary to disease elsewhere, and any operation performed on them must be considered merely palliative, except when the primary tumor has directly invaded the affected bone and can be removed with it.

Wengloski (Lancet, May 16, 1914) in sarcomata which involve a bone removes the disease of the soft parts, scrapes away the rest of the tumor upon the bone and lays bare the bone as if for resection. He then covers the soft parts with three or four thicknesses of gauze, covers the gauze with asbestos paper and the paper with sheets of metal. The metal is to keep condensed steam from the asbestos.

Steam is generated in an autoclave or even a kettle (the steam is under a pressure of from 3 to 5 atmospheres). A thick rubber tube about 6 feet long conducts the steam from the spout of the kettle to a metal nozzle. For the front of the bone a straight metal tube with terminal holes (like the 'rose' of a watering pot) is good. For the hinder surface of the bone a flattened curved tube with holes on its concave face is requisite. Through one or both of these tubes steam is applied to the exposed and diseased bone so as to kill but leave it *in situ* like a graft of dead bone.

Experiments show that when steam is applied to the surface of the femur a thermometer in the medullary cavity registers from 75° to 80° C. (167° to 176° F.) in from 4 to 4½ minutes. To gain the same result in the condyles of the femur takes 8 minutes; in the tibia, 3 minutes; lower jaw, 1½ minutes. The effect of the steam spreads only about 2 cm. (¾ in.) upwards or downwards along the bone from the site of application; thus if much of the length of the bone is to be sterilized it must be done bit by bit, the nozzle being moved along the bone. The results of Percy's operation on cancer of the uterus seem to show that moderate heat is fatal to malignant cells and to support Wenglowski's ideas.

CHAPTER LXXII

CHONDRECTOMY

It is well known that when osteomyelitis affects an active (fertile) epiphyseal cartilage one of two things may happen: (*a*) The cartilage may be destroyed and as a consequence growth of the bone cease. (*b*) The cartilage may be stimulated and growth of the bone become excessive. Where the diseased epiphyseal cartilage is that of *one* of the bones of the forearm or leg, deformity results because of the unequal growth of the two bones. The deformity may be treated by resecting a segment of the longer bone, thus shortening it. Ollier has operated in a more scientific fashion. He cuts down upon the epiphyseal cartilage whose active growth is producing the deformity and destroys it in part or completely. In the forearm bones the fertile epiphyseal cartilages are at the inferior extremity of the bones; in the tibia the fertile cartilage is superior.

CHAPTER LXXIII

OSTEOTOMY

SPECIAL INSTRUMENTS REQUIRED

hisels.—Although for many purposes the ordinary carpenter chisel, *l to cut hard wood,* is convenient and efficacious, yet most surgeons .n instrument fashioned out of one piece of metal; of these there are in- ble patterns. All chisels ought to be large enough to afford a good › the surgeon's hand; such as are so small as to require handling by

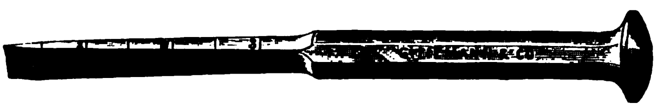
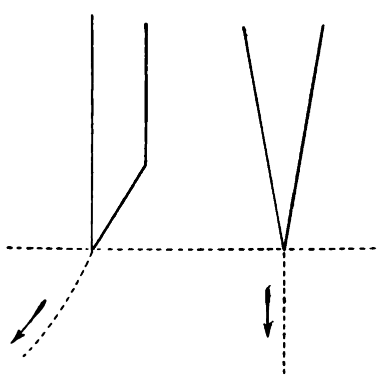


FIG. 1118.—Chisel.

;ers and thumb are difficult to use with precision. The most useful ıs a cutting edge ½ inch wide; a narrower instrument is also serviceable. .els are of three varieties:

The ordinary chisel with beveled edge. This is suitable for paring or bone and for excising wedges of bone. Figures 1118 and 1119 show linary chisels are not fitted to make linear incisions in bone.



Chisel. Osteotome.

FIG. 1119.

Gouges of various shapes are useful especially for the cutting of gutters ves in bone. Their cutting-edge should be beveled on the convex or de (Fig. 1120).

Osteotomes, or wedge-shaped chisels, are the only chisels suitable for a clean cut into or through a bone. Macewen's osteotomes, in three

sizes (Fig. 1121), are classical and efficient. Various surgeons have modified Macewen's osteotomes, but only in non-essential details.

2. **Mallet.**—A mallet is a necessary adjunct to the chisel. Wooden mallets are excellent, but are liable to split after having been boiled frequently. Figure 1122 shows how a leaden mallet becomes spoiled by use. A heavy wide-faced bronze mallet is efficient and durable. Many surgeons use an ordinary steel hammer. In an emergency any block of wood or a potato masher serves every purpose and is easily sterilized by boiling. Rawhide mallets are usually light and do not withstand boiling satisfactorily.

FIG. 1120.—Gouge.

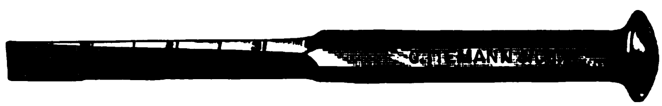


FIG. 1121.—Osteotome.

METHODS OF USING CHISELS

In osteotomy the old saying "the more haste, the less speed" holds true. One should work systematically. In cutting out a wedge-shaped piece from a bone one is tempted to insert the chisel and make it penetrate to the full depth of the cut which must be made. If one does this, the chisel will surely be jammed and gripped in the bone, causing trouble and loss of time. One should content one's self by merely cutting through the external layer of hard bone until the whole wedge is outlined, and then step by step penetrate more

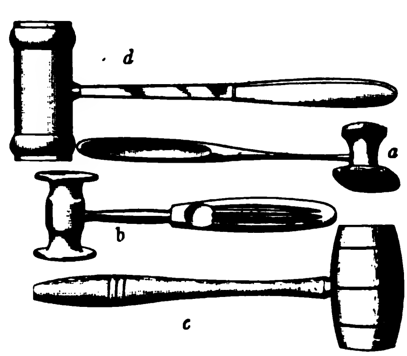


FIG. 1122.

a, lead mallet; face mushroomed from use; *b*, large bronze mallet; *c*, wooden mallet; *d*, Mixter's mallet of vulcanized fibre.

deeply. Macewen, who is a past master in the use of the chisel, seizes it low down in the palm of the left hand, so low, in fact, that the ulnar side of the hand is supported by the patient's body, the thumb of the left hand being extended up the chisel with its tip resting against the under surface of the expanded head of the handle (Fig. 1123). The object of this is to prevent any too sudden and great onward movement of the instrument, *e.g.*, when passing from cortical to cancellous bone. Whenever a few taps of the mallet have caused the in-

strument to penetrate a short distance into the bone it must be slightly withdrawn so as to avoid jamming. Slight pressure upwards with the left thumb generally suffices; often, however, a little lateral motion given the chisel will aid. Backward and forward motion of the instrument is not permissible; such motion is liable to break it.

In preparing for an osteotomy the part to be operated upon must rest on a sand-bag and should, if possible, be so placed that the chisel cuts away from

FIG. 1123.—Macewen's method of holding osteotome. (*Tubby.*)

important soft parts and toward the surgeon. The surgeon can work more accurately cutting toward than away from himself.

The size of the wound in the soft parts depends on the work to be done and the dexterity of the surgeon. The educated hand, using the chisel as a probe, is independent of the assistance of the eye. It is safer for those who have not

FIG. 1124.—Adam's saw.

had large experience to make an external wound sufficiently large to allow of the eye supervising the work.

When section of a large and strong bone is contemplated, three sizes of osteotome should be provided. The thickest-bladed instrument is used first. When this has penetrated the bone to such a depth that its thickness causes

it to become jammed, it is replaced by the next finer instrument which suffers no obstruction from the sides of the cut made by the previous osteotome.

3. **Saws.**—Saws are frequently used instead of chisels for dividing bone. The ordinary surgical saws, such as are used in amputations, are unsuitable for

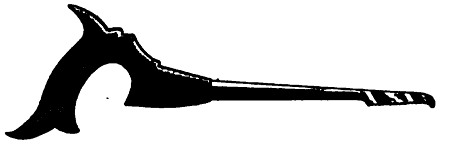


FIG. 1125.—Jones' saw. Note button on point.

osteotomy. Undoubtedly Adams' saw (Fig. 1124), or Jones' modification of it (Fig. 1125), is the best pattern. The ordinary "finger saw" is also useful (Fig. 1126).

FIG. 1126.—Finger saw.

Chain saws have been much used for the division of bone, but they are expensive, easily broken, difficult to handle and are now practically displaced by the simpler and more efficient wire saw of Gigli (Fig. 1127).

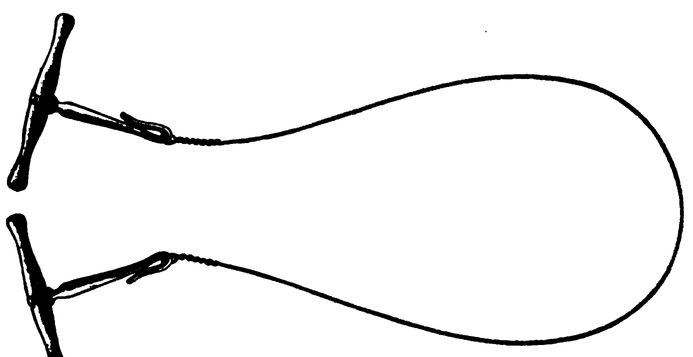


FIG. 1127.—Gigli saw.

METHODS OF PERFORMING OSTEOTOMY

I. Linear Osteotomy.—Macewen's supra-condyloid osteotomy for knock-knee is a classical example of linear osteotomy and will be taken as the type of such operations.

1. Administer a general anesthetic. Render the limb bloodless and apply the elastic constrictor. Place the patient on his back, arrange the limb to be operated on so that it lies with the outer side of the knee and lower part of the femur resting on a sand-bag. The best sand-bag is one of stout cloth about

18 × 12 inches in size and moderately (not tightly) filled with sand (Fig. 1128). The surgeon stands on the affected side of the patient. An assistant fixes the limb by grasping the tibia and the upper part of the femur.

Step 1.—Draw an imaginary line transversely one finger's breadth above the superior tip of the external condyle. Draw an imaginary vertical line

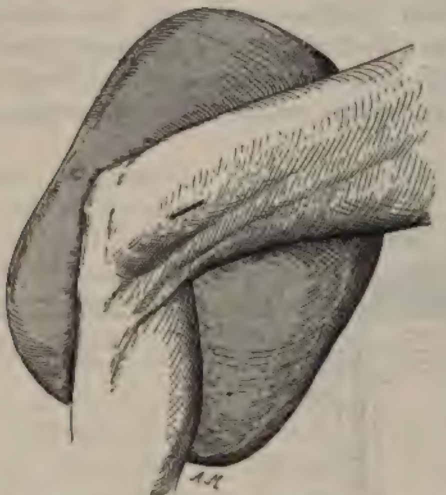


FIG. 1128.—Incision of supracondyloid osteotomy. (*Labey.*)

longitudinally ½ inch in front of the adductor magnus tendon (adductor tubercle). Note the point where these lines cross. At this point introduce a long-bladed scalpel or bistoury directly to the bone and, cutting upward, make a longitudinal incision of such size as to admit the largest osteotome. Endeavor not to wound the periosteum.

Step 2.—(A) Hold the knife *in situ*. Pass the largest osteotome (of Macewen's series) alongside the knife, down to the bone. Turn the blade of the osteotome transversely to the bone (Fig. 1129). Pass the edge of the osteotome over the bone until it reaches the posterior internal border and make it penetrate the bone from behind forwards and towards the outer side. After the cortical bone is penetrated, pass a finer osteotome along the face of the first one used and remove the latter. The wide groove left by the passage of the coarser gives great delicacy and precision to the use of the more delicate instrument. With this finer instrument complete the section of the femur along the line described, to a point near the outer layer of cortical bone. It is wise not to divide the outer layer of bone with the osteotome.

FIG. 1129.—Osteotomy. (*Macewen.*)

(B) Partially withdraw the osteotome. Change the direction of its cutting-

edge and make it cut through the whole cortical bone on the inner side of the femur (Fig. 1130).

(C) Once more change the direction of the osteotome and with it cut the bone from its anterior inner toward but not to its posterior external borders. Of course in many cases, *e.g.*, in children, the first line of bone section is all that is required, but in others where the bone is large the above systematic procedure will be found expeditious and *safe*. The osteotome ought not to be removed from contact with the bone until the bone section is completed, as its reintroduction through the small incision in the soft parts is a matter of much difficulty. All the procedures described can be carried out through a small wound.

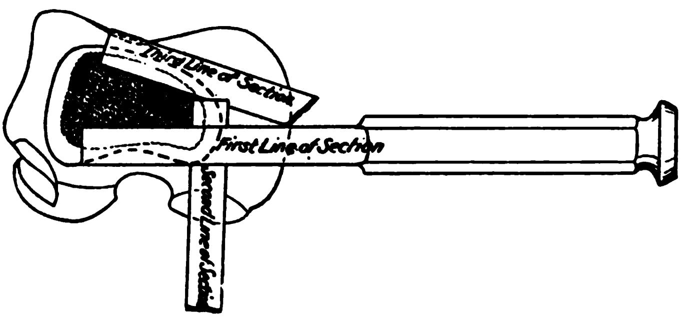


FIG. 1130.—Original lines of section of the femur in osteotomy.

Step 3.—Remove the osteotome. Cover the wound with an aseptic pad. With one hand grasping the femur at the site of operation and the other grasping the leg, complete the rectification of the deformity by breaking or bending the partially divided femur.

Step 4.—Apply dressings. Remove the elastic constrictor. Treat as a simple fracture of the femur. Both limbs are usually operated upon at the same sitting.

II. **Cuneiform Osteotomy.**—The operation as performed for angular anterior curvature of the tibia may be taken as typical. Render the limb bloodless. Apply an elastic constrictor (some surgeons omit this precaution as they fear increased subsequent oozing).

Step 1.—Make a longitudinal incision down to the bone over the most prominent part of the tibia. This cut need not be much longer than the width of the chisel, as the wound in the soft parts can easily be made to slide in various directions to expose different portions of the bone. Reflect the periosteum with the soft parts. Keep the wound open with retractors.

Step 2.—With an ordinary chisel outline the base of a wedge by cutting through the cortical bone. This base corresponds to the apex of the angular deformity (Fig. 1131) and should be *smaller* than that which it is believed will be necessary. With the chisel cut through the cancellous bone and remove a wedge-shaped portion of bone. Do *not* cut through the whole thickness of the

ıterior undivided portion, corresponding to the apex of the wedge, tured by manual force. Straighten the limb. If sufficient bone removed, it is easy to slice off more with the chisel until the ıount which permits of correction has been removed. If the :es with the correction it must be bent or broken by manual force th an osteotome.

If the wound tends to gape, introduce a Apply aseptic dressings. Immobilize. elevate the limb for twenty-four hours 'he subsequent treatment is the same as ıcture.

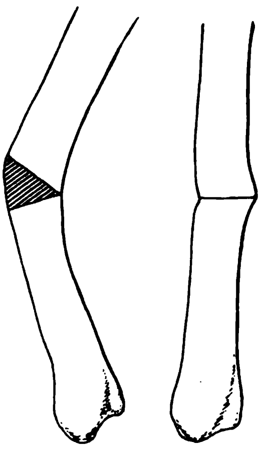


FIG. 1131.—Cuneiform osteotomy.

:utaneous Osteotomy by Means of a ıd type of this operation is that of W. ıe intra-capsular division of the neck of cases of anchylosis in bad position.

Introduce a long, narrow-bladed knife t a point one finger's breadth above the :ochanter major, and push it on until it he neck of the femur, over which it sed in a direction at right angles to the ıeck. The route taken by the knife is ıe parallel to Poupart's ligament. Leave *itu.*

?ass an Adams' or Jones' saw alongside of knife until the teeth of n contact with the femoral neck (Fig. 1133). Remove the knife. v divide the bone. While sawing one is liable to pull Adams's he cut in the bone and have much difficulty in reintroducing it. beak on Jones' saw prevents such an accident. Before obtaining ification it may be necessary to divide the tendons of the adductor ius and perhaps the rectus muscles.

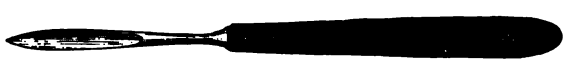


FIG. 1132.—Adam's knife.

ᴀpply aseptic dressings. Immobilize the limb in a position of ınd abduction.

gum. Knock-knee.—There are three bony deformities com- in knock-knee.

nce in size of the condyles, *i.e.*, elongation of the internal one.

g of the lower end of the diaphysis of the femur. Macewen found of 166 affected bones. In some cases the same effect is obtained ≥nding of the bone, by an elongation of the inner side of the femur y pushes down the inner portion of the epiphysis.

g of the upper end of the tibial diaphysis. The most important

deformity in knock-knee is the bending of the lower end of the femur, but all the deformities mentioned have had operations devised for their correction.

Osteotomy for the correction of genu valgum.

(*A*) Macewen's, directed against the bending of the lower end of the femur (see p. 968).

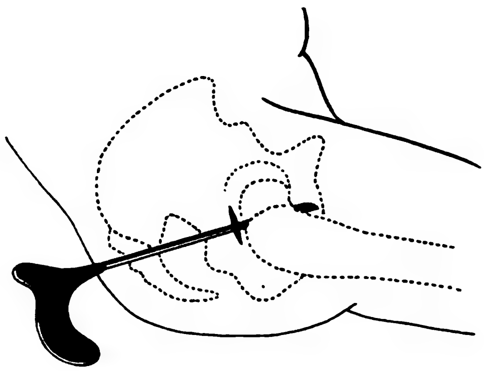


FIG. 1133.—Division of neck of femur.

(*B*) Supra-condyloid osteotomy as done in the New York Hospital for Ruptured and Crippled (Whitman, "Orthop. Surg.," 421):

Place the *inner* surface of the semiflexed knee on a sand-bag. Grasp the femur above the condyles and pass a short osteotome about the size of a lead-pencil through all the soft structures down to the bone at a point 1½ inches above the external tuberosity. The cutting-edge of the osteotome must be

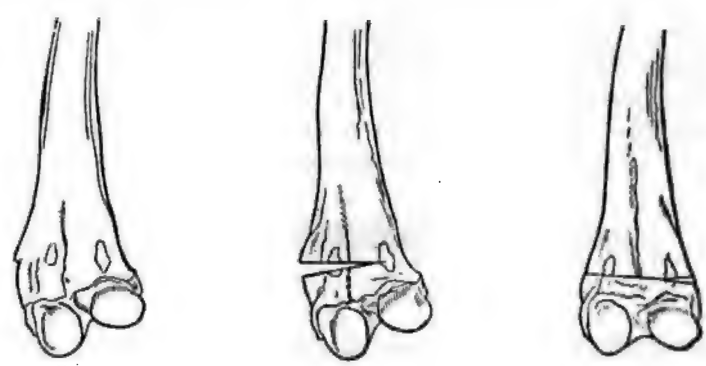


FIG. 1134. FIG. 1135. FIG. 1136.
FIGS. 1134, 1135 AND 1136.—Macewen's linear supracondyloid osteotomy.

kept parallel to the long axis of the thigh until it comes in contact with the bone when it is to be turned transversely to the bone. Drive the osteotome through the cortical bone until so much is divided that the remainder is easily fractured. The rest of the treatment is the same as in Method A.

Inspection of Figs. 1134, 1135, 1136, shows that theoretically Macewen's operation is the better, but it must be admitted that a clean osteotomy gives good results whether performed from the inner or the outer side.

Ogston's operation: Osteo-arthrotomy.—This, the first successful ion for knock-knee (1876), is directed against the real or supposed length- of the internal condyle.

p 1.—Flex the knee as fully as possible. Introduce a narrow-bladed r elongated tenotome (Adams's knife) through the skin at a point 2 or 3 above the tip of the inner condyle. Push the knife downwards, forwards

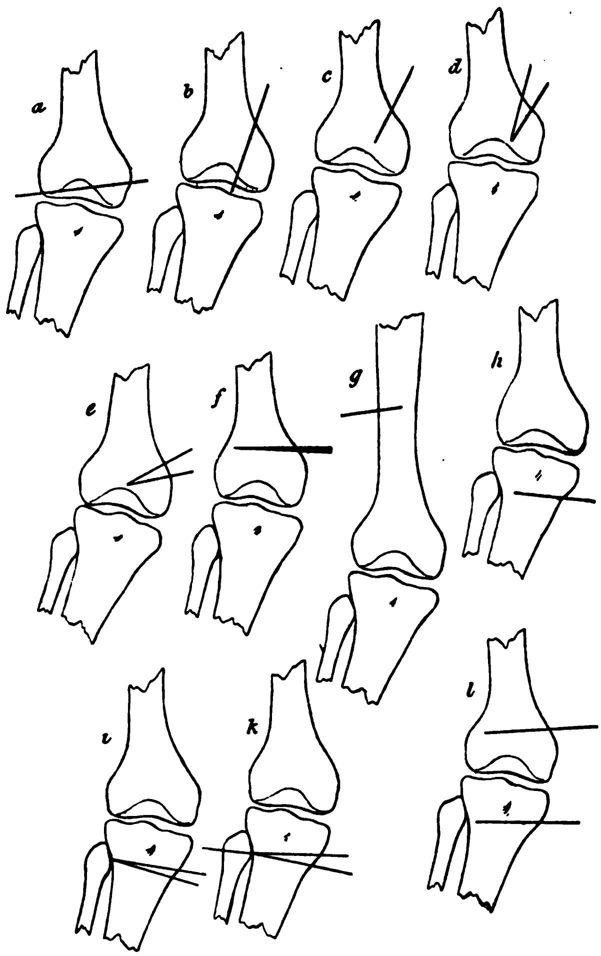


FIG. 1137.—(*Hoffa.*)

dale; *b*, Ogston; *c*, Reeves; *d*, Macewen's cuneiform osteotomy; *e*, Chiene; *f*, Macewen's supracondyloid; *g*, Reeves; *h*, Billroth; *i*, Mayer; *k*, Schede; *l*, Barwell.

twards until the point is felt in the intercondyloid space. Turn the edge knife towards the bone and in withdrawing it cut the soft structures to the

p 2.—Introduce an Adams's saw through the knife wound and divide the l condyle from above downwards for three-fourths of its thickness. Com-

plete the fracture by straightening the limb, when the loosened condyle will slip upwards (Fig. 1137).

Step 3.—Immobilize and treat as a fracture.

(*D*) Reeves' operation is similar to Ogston's but in it the bone section is made with a chisel down to but not through the articular cartilage, thus avoiding any direct opening of the joint. Fowler and Pilcher long ago showed that this operation has nothing to recommend it.

(*E*) Chiene's operation differs from Ogston's in that he removes with the chisel a wedge of bone from the base of the condyle. The operation is unnecessarily difficult.

(*F*) **Section of Tibia.**—*Step* 1.—On the inner surface of the tibia, midway between its anterior and posterior borders make a longitudinal incision down to the bone. The cut should be only large enough to easily admit the osteotome.

Step 2.—Introduce the osteotome and turn its cutting edge transversely to the bone. Divide the tibia from within outwards, "commencing from the posterior border and raising the osteotome gradually up until it comes into contact with the anterior surface of the lower portion of the tubercle, which is by far the most dense portion" (Macewen). Next divide the dense bone on the outer side of the tibia from before backwards. Complete the fracture by manual force. It is unnecessary to divide the fibula.

OSTEOCLASIS IN GENU VALGUM

(A) **Manual.**—Administer a general anesthetic. Place the patient on his back. Let an assistant firmly grasp and steady the upper portion of the thigh. With one hand grasp the femur immediately above the deformity, with the other hand grasp the leg. Fully extend the knee and endeavor forcibly to bring the limb into a straight position. When correction is obtained it is usually due to the production of one or several of the following lesions: Fracture, green stick or complete, of the lower end of the femur; separation of the femoral or tibial epiphysis or of both; fracture of the internal condyle (as produced in Ogston's operation); rupture of the external lateral ligament.

(B) **Instrumental Osteoclasis.**—This operation as applied to knock-knee is carried out in much the same manner as in the case of bow-leg and hence requires no description here.

Indications for Operation in Knock-knee.—Mechanical treatment by massage and apparatus often gives good results in moderate degrees of deformity in patients *under four years of age*. After the fourth year improvement cannot be expected from other than operative treatment, hence operation is positively indicated in every case of knock-knee where the patient is over four years of age, where *disability* is present, *provided that* the general health of the patient is fairly good. The operation, being practically without danger, is permissible for æsthetic reasons in patients whose health is good.

Choice of Operation.—**Osteoclasis.**—Theoretically, the danger of epiphyseal separation causing subsequent want of bone development is a serious objection

to osteoclasis, but experience seems to show that these dangers have been much exaggerated. Osteoclasis is suitable only in the very young where the bones are still soft. On the whole, however, osteoclasis whether manual or instrumental is very inferior to osteotomy in that it produces more injury than, and lacks the definiteness of the latter operation.

Osteotomy.—Only when the tibial curvature is much greater than the femoral does the former require division. This is a rarity. In very rare and exaggerated cases osteotomy both of the tibia and of the femur may be performed, although in these circumstances femoral osteotomy plus division of the biceps tendon has given as good or better results than double osteotomy. All other osteotomies for knock-knee have been practically superseded by the Macewen supra-condyloid operation or some modification of it.

CHAPTER LXXIV

BOW-LEG. GENU VARUM

Typical genu varum is the result of external bowing of the femur and of the leg bones. The maximum curve is generally near the knee. Bow-leg may be the result of lateral bending of the leg bones alone, the femur being unaltered. An anterior curvature of the tibia gives another form of bow-leg. Operative correction is demanded in all severe cases. Before the age of four or five years mild deformities may be corrected by mechanical appliances; after that age, operation affords the only prospect of cure.

Methods of Operating.—(I) **Linear Osteotomy.**—Note which bone or bones are most seriously affected. Usually in typical genu varum both the femur and tibia are badly curved. Note which part of the individual bone is most bent; it is this part which must be divided.

(a) If osteotomy of the middle third of the femur is indicated, make a vertical incision through the soft parts down to the bone on the outer or antero-external side and proceed as in supra-condylar osteotomy, in this case, however, cutting the bone from without inwards. (b) If the tibia is most affected, incise vertically the soft parts down to the bone over the inner surface of the bone at the point of greatest curvature. Introduce the osteotome and then turn it transversely to the bone and divide the cortical bone of the inner and outer sides of the tibia, and especially that of the anterior margin. Be careful not to injure the anterior tibial vessels and nerves which lie close to the outer surface of the bone. Fracture the posterior layer of cortical bone by manual force. Forcibly fracture or bend the fibula. If this is impossible, palpate the fibula and make a small incision down to it through the soft structures of the outer side of the leg. Introduce a very narrow osteotome and divide the bone. (c) If femur and tibia are both markedly curved, operate on both at the same sitting.

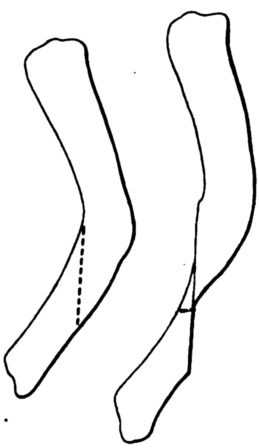


FIG. 1138.—Oblique osteotomy.

Note.—The object of the surgeon is to correct the deformity. If division of one bone is insufficient, then divide the other as well; if this is insufficient repeat the operation at whatever places it may be demanded. Macewen has performed ten osteotomies on the same patient at the same sitting and obtained a good result.

II. **Cuneiform osteotomy** is particularly suitable in cases of anterior curvature of the tibia (see p. 970).

III. Oblique Osteotomy (Ollier).—In some cases, especially of anterior curvature of the tibia where there is much shortening, oblique division of the bone (Fig. 1138) permits elongation. To attain this elongation it may be necessary to lengthen the tendo Achillis by means of any one of the well-known methods.

FIG. 1139.—Grattan's osteoclast.

FIG. 1140.—Collin's osteoclast.

IV. Osteoclasis.

(A) **Manual.**—Grasp the bone affected above and below the point of the greatest curvature and bend it straight or produce a fracture. In the very young a green-stick fracture is a desirable lesion to produce. It is often necessary to support the point of greatest convexity on a fulcrum (*e.g.*, a padded wedge of wood) before sufficient force can be applied. It may be necessary to produce multiple fractures.

(B) **Instrumental.**—The necessary fracture or bending may be more precisely and definitely produced by means of an osteoclast. Probably Grattan's osteoclast (Fig. 1139) is the best. Place the limb in the instrument in such a fashion that the movable arm (a) is applied to the point of greatest convexity while the opposite or concave side of the limb is supported by the two parallel fixed arms of the osteoclast. By means of the screw (x) make a movable arm (a) press against and fracture the limb. Fig. 1140 shows Collin's osteoclast.

By whichever means the limb is straightened, it must be fixed in good position by plaster of Paris or apparatus and treated as an ordinary fracture. In the treatment of bow-legs osteotomy and osteoclasis seem to give about equally good results.

CHAPTER LXXV

OPERATIONS ON THE PELVIC BONES

Operations on the bones of the pelvis are indicated in acute osteomyelitis; tuberculosis; sarcoma, etc.

1. **Acute Osteomyelitis and Periostitis.**—The method and time of operation must vary according to circumstances. "In the severest cases with high fever, great local pain and swelling an incision should at once be made at the point of greatest tenderness or swelling" (Tillmanns), all sequestra and diseased bone removed and drainage provided. When the disease is on the outer side of the ilium the above advice is easily carried out; when, however, the disease is principally on the inner side of the bone it is necessary to trephine or better to excise a larger or smaller amount of the ilium in order to provide proper drainage. To do this the author has found it necessary to operate several times, in an individual case. When there is extensive disease, extensive exposure of the bone is necessary.

When the inflammation and swelling are diffuse and fever is high more systematized resection of bone is necessary and the whole affected bone should be early removed. When the local and general symptoms of the disease are mild, non-operative treatment should be adopted until recovery takes place or the incidence of abscess or threatening symptoms indicate operation.

2. Chronic pyogenic osteomyelitis with fistula calls for operation.

3. Tuberculous osteomyelitis is usually situated near and commonly involves one of the joints so that the treatment is generally directed primarily against the arthritis (hip-joint disease; sacro-iliac disease).

4. Neoplasms. All malignant neoplasms demand excision provided there is a moderate chance of success. All non-malignant neoplasms threatening life from pressure, etc., similarly demand removal. All other neoplasms demand removal provided that the operation is not one of much gravity. The usual rule of very wide excision prevails in operations for malignant tumors; when removing such neoplasms as osteomata and chondromata a portion of the pelvis itself ought to be removed to make sure that the base of the neoplasm is not left.

Every extensive operation on the ilium requires free exposure of the bone. This may be obtained in various but similar ways.

A. **Sprengel's Method.**—Make an incision from the anterior superior spine of the ilium, downwards along the anterior border of the tensor vaginæ femoris and divide the deep fascia (Fig. 1141). From the upper end of the incision cut backwards along the iliac crest dividing the fascia and the origin of the glutens medius and minimus.

Through the above incision separate the muscles and periosteum from the pelvis and retract them downwards and backwards. This gives good exposure of the ilium and of part of the acetabulum. Through this incision Kocher removed an exostosis from the acetabulum. When the active operation is finished, the flap is easily replaced.

B. **Larghi's Method** (see p. 994).

C. **Kocher's Method.**—Kocher excised one-half of the pelvis for sarcoma as follows:

Step 1.—Make an incision from the sarco-iliac synchondrosis forwards along the iliac crest and Poupart's ligament.

Step 2.—Divide the abdominal muscles attached to the iliac crest and Poupart's ligament; separate the transversalis fascia and peritoneum from the tumor until the iliac vessels are exposed. Retract the iliac vessels and the anterior crural nerve inwards.

Step 3.—Isolate and divide the muscles passing under Poupart's ligament external to the great vessels. Divide the rectus femoris, sartorius, tensor vaginæ femoris. Separate the gluteus medius and minimus bluntly from the ilium until the sacro-iliac articulation is reached. Anteriorly divide the ilio-psoas muscle and the capsule of the hip-joint.

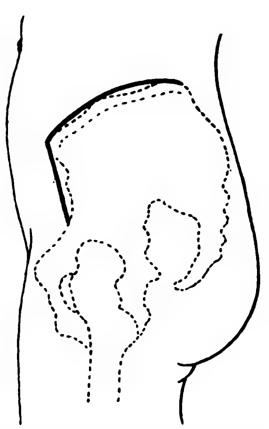


FIG. 1141.—Sprengel's incision.

FIG. 1142.—Result of excision of pelvis. (*Kulenkampff.*)

Step 4.—Divide the horizontal ramus of the pubis and the ascending ramus of the ischium.

Separate the sacro-iliac articulation and dislocate the bone downwards.

Step 5.—Separate the rest of the pelvic attachments by blunt and sharp dis-

section. The flexors arising from the tuber ischii and the sacro-sciatic ligaments require division. Excise the head of the femur. Remove the mobilized portion of pelvis.

Step 6.—Suture the abdominal muscles to the glutei. Close the wound by deep and superficial sutures after providing freely for drainage.

Kocher remarks that the bleeding is only moderate as no large vessels are injured but that it might be well to ligate the internal iliac vessels before retracting them in Step 2.

D. **Kulenkamff's Method.**—*Step* 1.—Secure temporary hemostasis by Momberg's method. Make an incision along the crest of the ilium and Poupart's ligament. Separate the iliacus muscle (if it is not involved in the disease) and retract it along with the iliac vessels inwards.

Step 2.—Perpendicularly to the first incision make a cut reaching down to the trochanter major. Open the hip-joint and decapitate the femur.

The rest of the operation is practically the same as Kocher's. Figure 1142 shows the result obtained by Kulenkamff. (Beiträge z. klin. Chir., lxviii, 768).

Excision of Symphysis Pubis.—Tuberculous osteomyelitis affecting the pubic bones and the symphysis calls for early operation. The disease may be

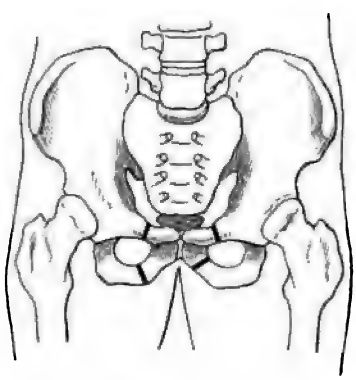


FIG. 1143.—Excision of pubis.

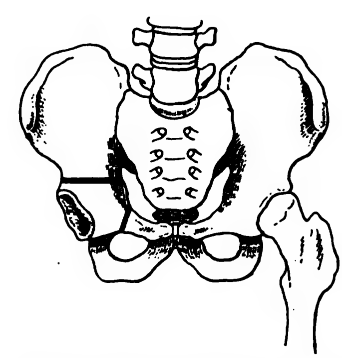


FIG. 1144.—Excision of acetabulum.

exposed by an incision directly over it; all affected bone cut away with chisel and mallet and all abscesses opened and curetted. If no distinct and separated sequestra is present v. Bünger recommends that a transverse incision be made immediately above the pubis, the soft parts separated and the bone divided subperiosteally beyond the disease (Fig. 1143).

The results of the operative treatment of pubic tuberculosis are good.

Excision of the Acetabulum.—Schmidt's Method.—*Step* 1.—Open the hip joint through Langenbeck's incision (p. 989). Dislocate the head of the femur (if necessary excising it).

Step 2.—Adduct and rotate the limb outwards. From the middle of the wound make a cut at right angles forwards towards the anterior inferior iliac spine. This cut penetrates to the bone. By blunt dissection separate the peri-

osteum and overlying soft parts from the ilium above the acetabulum from the anterior inferior spine to the sciatic notch.

Step 3.—With chisel and mallet divide the ilium transversely above the acetabulum (Fig. 1144). Be careful not to injure the pelvic contents.

Step 4.—Divide the horizontal ramus of the pubis with a Gigli wire saw.

Step 5.—With a periosteal elevator separate the soft parts from the ischium below the acetabulum. Divide the ischium with a Gigli saw or a chisel (Fig. (Fig. 1144).

Step 6.—Seize the acetabulum with bone forceps and remove it, dividing any obstructing connections with scissors.

Step 7.—Provide for drainage. Close the wound. Dress. Put up in a position of marked abduction.

CHAPTER LXXVI

SACRO-ILIAC DISEASE

Jacobson and Rowlands ("Operations of Surg.," ii, 874) write:

"It has been shown that the prognosis in this disease, usually looked upon so grave, is much better if the same radical methods of treatment, which ive proved so satisfactory in other joints, are applied to the sacro-iliac nchondrosis."

Mr. Collier first drew attention to the above fact with a case successfully ated by trephining (Lancet, 1889, vol. ii, p. 787), and Mr. Makins and r. Golding Bird followed, each surgeon publishing three successful cases Clin. Soc. Trans.," vol. xxvi, p. 127, and vol. xxviii, p. 186).

The following points are taken from these papers:

Operation.—The joint is exposed by a crucial incision (Makins), or by a) (Collier, Golding Bird). In the words of the last-named surgeon, "a iicircular flap of skin and subcutaneous tissue over the iliac area of the nt, and having its convexity corresponding to the posterior edge of the ilium, dissected upwards and forwards, and the underlying glutæi are detached. e bone being thus freely exposed, a large trephine is applied at the root of : posterior inferior iliac spine, and in a line drawn from the top of that spine the junction of the anterior with the middle third of the iliac crest. . . . . e ilium at the seat of operation is very thick, but the disc of bone removed uld reach quite down to the joint." The trephine-opening is then sufficiently arged, the articular surfaces cut away with a gouge or forceps sufficiently enable the surgeon to explore the pelvis surface of the joint, and to liberate pus lying on this aspect. The sharp spoon, or Barker's flushing gouge, hen thoroughly used, all fragments of bone, granulation tissue, or loosened tilage removed, and any sinuses present laid open. Sterilized iodoform ing been next applied, the soft parts are lightly drawn together with a sutures. A long outside, or a Thomas's hip-splint, should be used at t, but subsequently all that is needed is a well-fitting pelvic belt, as advised Mr. Hilton."

Bardenheuer and Picqué ("Journ. de Chir.," Sept., 1910) have each deibed more systematic methods of excising the sacro-iliac joint. Picqué's thod is the one described here.

Step 1.—Make a curved incision penetrating to the bone along the posterior rd of the iliac crest and continued down the border of the sacrum to the el of the third posterior-external tubercle. With periosteal elevator reflect periosteum and superjacent soft parts from the out... the posterior tion of the ilium.

Step 2.—The sacro-iliac joint is so situated that to reach it a portion of the ilium must be removed (Fig. 1145). The excision of the segment of bone may be complete or partial.

(*a*) *Complete.*—With an osteotome divide the iliac bone vertically from the crest down to the outer and upper corner of the great sciatic notch (Fig. 1146).

FIG. 1145.—Exposure of sacro-iliac joint.

(*b*) *Partial.*—Make the vertical incision shorter and supplement it by a transverse one (Fig. 1146) in such a fashion as to leave the sciatic notch intact.

Having divided the ilium pry up the fragment of bone with an elevator, divide its ligamentous attachments and remove it. This removes the iliac portion of the sacro-iliac joint and freely exposes the articular and adjacent portions of the sacrum.

FIG. 1146.—Exposure of sacro-iliac joint. (*Picqué.*)

Step 3.—Systematically with scoop, rongeur forceps and chisel remove all disease from the sacrum. In doing this, so shave away bone that no irregular pits or tunnels are left which would interfere with proper drainage. If the disease extends to the sacral foramina, working in the above systematic fashion permits the exposure and isolation of the nerve trunks which would be exposed to much injury if the curette was used blindly. The amount of bone removed must vary with the extent of the disease. In one case, Picqué writes,

"the wound will have a bony floor formed by the anterior portion of the wing of the sacrum united to the ilium by the anterior sacro-iliac ligament, in another case the wound will penetrate the pelvis exposing the sacral nerve trunks, the iliac vessels and the ureter. Thus the resection of the sacrum like that of the ilium may be partial or complete." When extensive resection of the sacrum is necessary it will usually be found that nature has already protected the pelvic organs by a deposit of strong fibrous tissue.

Step 6.—Close part of the wound with sutures and pack the rest with gauze. Picqué writes, "however thorough the resection has been, points of caries will always appear on the surface of the spongy bone, interfering with cicatrization, there will be exuberant granulations from the superficial soft parts and the dressings should be made curette in hand." The duration of post-operative treatment varies much (six weeks to three months—Bardenheuer; three to eight months—Picqué). The author has had no experience with the Bardenheuer-Picqué operation but it strikes him that the use of Mosetig's iodoform wax plug might facilitate healing.

Results.—Bardenheuer reports on series of sixteen cases with 69 per cent. recoveries and a second series of four cases with 100 per cent. recoveries, Picqué reports six cases with 66 per cent. recoveries.

CHAPTER LXXVII

HIP

Snapping hip; Hanche a ressort; Schnellende Hufte; Schnappende Hufte, are names given to the same affection. On very slight motion of the hip the patient can produce a palpable and audible snapping which simulates a dislocation in a very persuasive manner. The trouble is due to a prominent sausage-shaped mass of tissue slipping forwards or backwards over the upper part of the trochanter major. In one case observed by the author fixation of this mass by the operator's fingers prevented snapping. The mass consists of part of the gluteus maximus. (Heully, "Rev. de Chir.," May, June, July, 1911; Bayer, "Archiv für klin. Chir.," lxxxii, 266; Voelcker, "Beiträge z. klin. Chir.," lxxii, 619; The author, "Annals Surg.," lviii, 59.)

In one of the author's cases there was much disability and a good result was obtained by the following operation:

From about ½ inch above the great trochanter make a cut downwards along the middle of the bone for about 3 inches. Divide the fascia lata corresponding to the skin wound. Incise the periosteum longitudinally on the lower part of the trochanter and elevate a small periosteal flap. Suture the posterior edge of the wound in the fascia lata to the periosteal flap and to the insertion of the vastus externus. Suture the anterior edge of the fascial wound so as to make it overlap the line of fixation of the posterior edge. Close the skin wound. Dress. Immobilize the hip for several weeks.

In one case Voelcker exposed the fascia lata over the great trochanter and divided it longitudinally behind the palpably thickened ileo-tibial band. Underneath the fascia the gluteus maximus appeared and contained a strong band of tendon which was inserted into the ileo-tibial band. Division of this band without suture of the fascia led to cure.

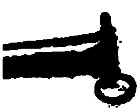
Iodoform Injection.—Krause describes the introduction of the trocar and cannula as follows: The trocar ought to be from 2¾ to 3½ inches in length. The patient lies flat on his back. Flexion of the thigh should be avoided if possible, while abduction and external rotation *must* be avoided. The thigh should be in a position of adduction and slight internal rotation. Introduce the trocar at right angles to the axis of the femur, at a point immediately above the tip of the trochanter major and midway between its anterior and posterior borders. Push the trocar slowly onward until its point strikes bone (the head of the femur or the neck near the head). Adduct the limb strongly, keeping the point of the trocar constantly in touch with the femoral head, push the instrument cautiously upwards and inwards until bony obstruction is again encountered. The point of the instrument is now lying between the head of the

ı of the acetabulum. Withdraw the stylette and push the ıer into the joint. The method of injecting, the material : after-treatment are the same as have been described in the on upon the knee.

:ions.—Rovsing ("Annals Surgery," Dec., 1909) advises the : vaseline into joints affected with traumatic dry arthritis. escapes through the cannula no injection of vaseline should lear synovial fluid escaping does not contraindicate injection. : 20 c.c. of vaseline is the correct quantity to throw into the

:annula is the proper instrument to employ—a cannula with ιo trocar is too dangerous.

ad a special apparatus made: (Fig. 1147) "a tube of india g, which at one end is provided with a brass ring which can



g, Annals of Surgery.)

FIG. 1148.—(*Rovsing, Annals of Surgery.*)

he ordinary vaseline tubes, while the other end can be partly :annula and partly into a close fitting cover, which fits the g the boiling can be closed with a little cover; provided with ɔer tube is screwed on to the vaseline tube and is now boiled for fifteen minutes before the injection. Then the joint is ıincon is removed, and the presence of synovia in the joint ıch a case catch the synovia in sterile glass tubes for examina- nd to be turbid and fluffy the injection of the vaseline is none or only an inferior mass of clear synovia is found, the ıken direct from the cooking vessel and connected with the ›nnection tube, which after the cover has been removed can ıt on to the cannula. The vaseline is now driven through ıla in this way; the vaseline tube is rolled up from the bottom ' little handle (Fig. 1148). By this means every possibility of seline passing from the tube to the joint is precluded, and the ' respect practical."

injecting insures against missing the hip-joint by exposing ;h a small incision just above the trochanter.

Arthrotomy.—Three are several routes through which the hip-joint may be opened.

I. **Anterior Arthrotomy.—Method A.**—*Step* 1.—From a point about 1 inch below and a finger's breadth internal to the anterior superior iliac spine make an incision 3 or 4 inches in length downwards along the inner border of the sartorius (Fig. 1149). Expose the inner border of that muscle and retract it outwards; this exposes the tendon of the rectus femoris which must be retracted outwards, exposing the ilio-psoas muscle. Retract the psoas *inwards*. The joint capsule is now exposed.

Step 2.—Flex and abduct the thigh, rotating it outwards. This permits more free access. Incise the capsule. Explore the joint. If drainage is required, provide such and partly close the wound.

Method B.—*Step* 1.—From a point about ½ inch below and external to the anterior superior iliac spine make a 3- or 4-inch incision downwards and

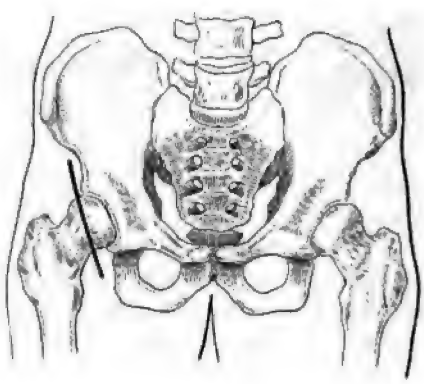


FIG. 1149.—Incision of anterior arthrotomy of hip.

slightly inwards. The upper portion of the cut runs along the outer border of the sartorius, lower down where the sartorius and tensor vaginæ femoris separate, the cut takes a course midway between these muscles. Retract the sartorius and rectus femoris muscles inwards. The joint capsule is now exposed.

Step 2.—Same as in Method A.

If on account of suppuration it seems desirable to provide further drainage through a counter-opening, Labey advises the following procedure: Abduct the thigh so as to make the adductor muscles prominent. Locate the adductor longus. Make a 4-inch incision along the outer border of this muscle, beginning about one finger's breath from the fold of the groin and a little external to the root of the scrotum. Divide the skin and subcutaneous tissue. Retract the long saphenous vein outwards; ligate and divide any of its branches which cross the wound. Divide the deep fascia along the outer border of the adductor longus. Push the finger between the adductor longus and the pectineus which lies immediately external to it. The thigh being now flexed as well as abducted, hook the finger under the pectineus. Introduce a closed forceps through the

arthrotomy wound, make the forceps traverse the joint inwards and downwards so as to make the inner and lower part of the capsule prominent and to come against the finger pushed into the secondary wound (Fig. 1150). Guided by the finger, make an incision through the capsule on to the forceps. With the forceps pull a large drainage-tube through from one wound to the other.

II. **Posterior Arthrotomy.—Method A, Langenbeck's Method.**—Place the patient on his healthy side (latero-ventral position). Flex the thigh to a position midway between extension and flexion at a right angle to the body (45°).

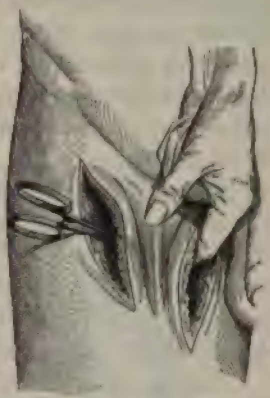


FIG. 1150.—Drainage of hip. (*Labey.*)

Step 1.—Beginning at a point about two fingers' breadth below the tip of the trochanter, make an incision along the mid-line of the trochanter in the long axis of the femur, upwards for about 4 to 4½ inches towards the posterior superior iliac spine (Fig. 1151). Divide the skin and subcutaneous fat so as to expose the gluteus maximus and the trochanter which is covered by the strong flat tendon of the gluteus maximus.

Step 2.—Divide the tendon on the trochanter in the line of wound and continue this division upwards so as to penetrate the gluteus maximus by separating its fibres. Retract the edges of the muscular wound exposing and then dividing the layer of fat covering the deeper structures. Expose the pyriformis (posterior and inferior) and the gluteus medius (anterior and superior). Note and penetrate the groove between these two muscles. Retract the edges of this deep wound so as to expose the posterior surface of the capsule.

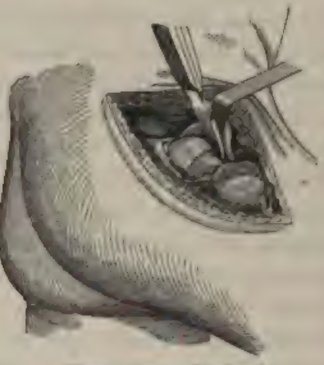


FIG. 1151.—(*Esmarch and Kowalzig.*) FIG. 1152.—(*Labey.*)

FIGS. 1151 AND 1152.—Langenbeck's arthrotomy.

Step 3.—Incise the capsule (Fig. 1152).

Method B.—Kocher's Curved Incision.—This method is described in the chapter on arthrectomy.

Arthrectomy. Anterior Incision.—Several methods have been devised for approaching the joint by the anterior route only Barker's plan will be described. This operation is enthusiastically advocated by A. E. Barker.

Step 1.—See Anterior Arthrotomy, Method B.

Step 2.—Open the joint capsule by an incision parallel to the neck of the femur. Explore. Do *not* dislocate the head of the bone through the incision. Divide the neck of the femur with a fine saw (Adams') or an osteotome. Remove the head of the bone. Removal of the normal femoral head is exceedingly difficult, but when tuberculous disease is so advanced that excision is necessary, the tissues are so altered and softened that extraction of the head is usually easy; to this rule there are some striking exceptions, when the head of the femur may require to be chiseled from the cotyloid cavity.

Step 3.—With the irrigating curette scrape away all soft broken down tissues. With long forceps and scissors dissect away all evidently diseased synovialis, etc. Examine the acetabulum and its surroundings and if found diseased, remove the foci with the curette, chisel, or gouge. Thoroughly douche the cavity with warm water tinged to a dark sherry color with tincture of iodine.

Step 4.—(*a*) No evidences of secondary (pyogenic) infection is present. Fill the wound with iodoform-glycerine or iodoform and formalin in glycerine. Close the wound without drainage.

(*b*) Sinuses are present or there is evident pyogenic infection. Provide for free drainage. Partly close the wound.

After-treatment.—Barker writes as follows:

"No splint is required immediately after the operation, the limb lying in good position, as a rule, if left to itself, no muscles having been divided. If there be any tendency to displacement a weight-extension will be the most suitable means of correcting it in the first instance. As the wound lies in front and is small, there is no difficulty in dressing it without moving the patient in the least, hence another reason for discarding splints at first. But when the wound is in a fair way to heal, the author is in the habit of putting the patient upon a double Thomas' splint, in which he can be removed from bed and be carried out for change of air without the least disturbance of the limb or of the dressing on the wound."

External or Langenbeck's Incision.—König's Method.—Place the patient on his sound side with the operating-table so arranged that a good light falls on the hip. Three assistants are necessary. One stands opposite the surgeon, one at the patient's back, and the third where he can manipulate the patient's limb. The surgeon stands behind the hip. The thigh is in a position of semiflexion.

Step 1.—Make a five inch incision over the middle of the trochanter major in line with the long axis of the femur. Rather more than half of this incision lies above the trochanter, between it and the posterior superior spine of the ilium (Langenbeck's incision, Fig. 1151). The knife is made to penetrate to the bone in the first cut.

Step 2.—With long-bladed retractors separate the edges of the wound, ex-

ose the capsule and divide it. Divide the periosteum of the trochanter in the ne of the wound. Do *not* separate the trochanteric muscular insertions.

Step 3.—With a broad chisel *partially* cut off a shell of bone from the anterior ıd from the posterior margins of the trochanter. Complete the separa- ɔn of the shells of bone by blunt force, leaving them loosely attached to the aft of the femur, the periosteum and soft structures acting as a hinge (Fig. 53, c, c). The separated portions of ɔne bear the insertions of the trochan- ric muscles. The remaining portion of ochanter (b) must be removed flush with ıe femoral neck by means of the chisel or ɔne forceps.

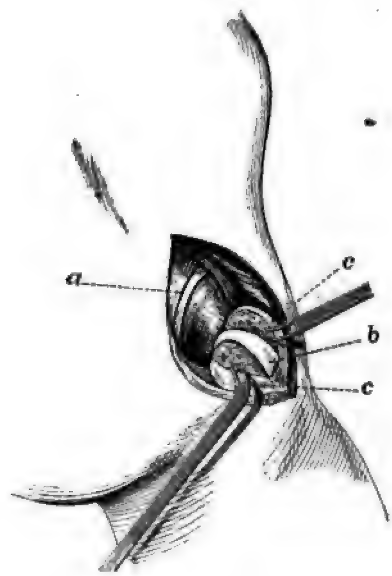


FIG. 1153.—König's arthrectomy.

Step 4.—With retractors expose the moral neck. Choose the point at which he neck is to be divided. With a peri- steal elevator bare the bone of the neck ıt the line of section. Divide the bone. For this purpose use a finger saw, or etter, the Gigli wire saw.

Step 5.—Removal of the femoral head.

König writes as follows: "The removal of the head is often difficult. Sometimes it has sunk into the cotyloid cavity which has been widened by disease and whose inequalities of surface have hooked them- elves on to similar inequalities of the emoral head; sometimes it is so changed in form that it has become firmly ızed in an excavation of the acetabulum; occasionally its surface is partially or ıtirely united to the bone of the acetabulum. In other cases, especially hen acute osteomyelitis has been present, the epiphysis is separated and the ead itself is anchylosed to the acetabulum.

"In simple cases when room is made by pulling the limb downwards one ın remove the head with a periosteal elevator. In difficult cases a specially


FIG. 1154.—König's lever.

rong, spoon-faced lever is required." (The author has had one made of ıe following dimensions, $14 \times \frac{3}{4} \times \frac{1}{4}$ inches (Fig. 1154). It reminds one f a burglar's "jimmy," but is thoroughly efficient.)

"In unusually difficult cases one may chisel away a portion of the posterior uperior rim of the acetabulum (a, Fig. 1153). This would be done in any vent after the removal of the head."

Examine the trochanter and the remnant of the neck. If disease is present n these structures attack it with chisel and sharp spoon.

Step 6.—Examine the cotyloid cavity both by touch and sight. Remove sufficient of the posterior superior cotyloid rim to permit of free inspection of the cavity. If disease exists in the pelvic bones remove it *thoroughly* with chisel and spoon. In cases where the disease has invaded the pelvis and caused iliac abscess, the latter must be independently opened anteriorly above Poupart's ligament, its contents evacuated, its cavity cleaned, filled with iodoform-formalin glycerine and sutured.

Step 7.—**Excision of the Synovialis.**—Separate the synovialis from the rim of the acetabulum and from its inferior insertions, and dissect it out. Long stout dissecting forceps and scissors curved on the flat are convenient for this purpose. Changes in the position of the limb assist in giving free exposure. All the synovialis may be excised as above, except sometimes a pouch which runs down to the lesser trochanter and must be thoroughly curetted. The sharp spoon so often recommended for the removal of the synovialis is practically useless for the purpose.

Step 8.—Irrigate the wound with hot water. The addition to the water of sufficient tincture of iodine to make it a sherry color is valuable. Dry the wound with sterile gauze. Introduce a cannula or tube into the wound. Close the wound with deep and superficial sutures. Place one or more sutures (not tied) in such position that when the tube is removed they may be tied and effectually close the wound. Through the tube fill the wound cavity with iodoform-glycerine or iodoform-formalin-glycerine or Beck's bismuth vaseline. Remove the tube. Fasten the last sutures. Apply ample dressings.

James E. Moore recommends filling the wound cavity with Mosetig's bone plug. Mosetig himself originally only used this plug to fill cavities actually cut in the bone itself. His plan in articular caries was to cut (not scrape) away the focus, thoroughly dry the bone cavity left, fill the cavity with the iodoform wax, cover the plug with rubber tissue and gauze until the rest of the operation was completed, then he removed the rubber tissue and gauze and closed the wound after introducing short drainage-tubes. Moore in one case could not obtain sufficiently perfect hemostasis to permit the use of the "bone plug," hence he packed the wound with gauze for some days and introduced the plug secondarily with good results.

If secondary infection is a feature of the case and especially if sinuses exist, then the above treatment is improper; the sinuses must be cleaned by the sharp spoon, rubbing with gauze or by dissection. Filling the cavity and sinuses with Beck's bismuth paste seems to be efficacious.

After-treatment.—Put the patient in bed. Apply extension by means of weight and pulley in a position of slight abduction. Keep up for from six to eight weeks or longer. Use nocturnal extension for a period of one or two years.

Within three weeks, if all goes well, begin gentle passive motion. After the wound is satisfactorily healed massage combined with passive movements is indicated, and active movements may be begun. After the lapse of eight weeks the patient may be encouraged to walk with crutches. Huntington

:s that in most cases of hip-joint disease, whether tuberculous or of infective origin, the primary focus is situated in the neck or the head femur. Guided by X-ray findings, he therefore trephines on the outer : of the trochanter major near its base and through the trephine opening s the neck of the femur until he reaches the disease (Fig. 1155). If :nt disease to account for the symptoms is found before the epiphyseal ge is reached, do not penetrate that structure; if sufficient disease is not in the neck, then the epiphyseal cartilage must be penetrated and the :ntered. The time when this operation may promise most is the time ıon-operative treatment is usually considered indicated, viz., early. The ıent is the same as was advocated by Macnamara (Huntington, "Surg., and Obstet.," ii, p. 406).

FIG. 1155.—Tuberculosis of hip. (*Huntington.*)

gular Incision. Kocher's Operation.—This incision may be used for tomy as well as for arthrectomy. Place the patient on his sound side in tero-ventral posture. Slightly flex the hip. Let an assistant grasp the as to change the position of the thigh according to directions.

:p 1.—Beginning at the posterior margin of the base of the trochanter , make a cut upwards to the posterior angle of the summit of the tro- :r (Fig. 1156); at this point change the direction of the incision and cut ds and backwards towards the posterior superior iliac spine, *i.e.*, cut :l to the fibres of the gluteus maximus and expose that muscle. Split ndon of the gluteus maximus in the direction of its fibres, and enlarge

the deep wound upwards and backwards by splitting the muscle itself in a space between its fibres (Fig. 1157).

Retract the edges of the deep wound, exposing the gluteus medius at its insertion into the trochanter.

Step 2.—Rotate the hip slightly inwards so as to make prominent the posterior angle of the summit of the trochanter. Find the groove between the gluteus medius and minimus above and the pyriformis below. Beginning at this point, separate with elevator or knife the insertions of the gluteus medius and minimus along with the corresponding periosteum from the trochanter until the intertrochanteric line is reached anteriorly. At this point separate the insertion of the iliofemoral ligament. While doing this flex the thigh and rotate it outwards.

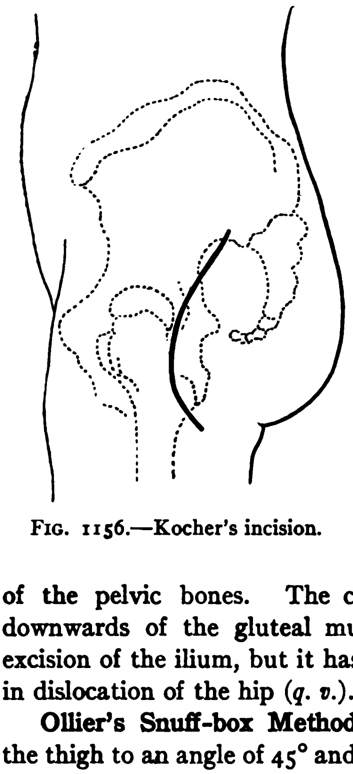


FIG. 1156.—Kocher's incision.

Step 3.—Divide the articular capsule along the lower edge of the pyriformis tendon; flex the thigh and rotate it inwards so as to gain access to and divide the insertion of the pyriformis. With elevator or chisel (removing a thin shell of bone if desired) separate the insertions of the obturators and gemelli.

The rest of the operation requires no special description.

Larghi's High Curved Incision.—A. Von Bergmann ("Archiv. für klin. Chir., lxix, 592) strongly recommends the above incision in cases where there is considerable involvement of the pelvic bones. The cut skirts the iliac crest and permits reflection downwards of the gluteal muscle. The operation was originally devised for excision of the ilium, but it has been used in tuberculous coxitis and especially in dislocation of the hip (*q. v.*).

Ollier's Snuff-box Method.—Place the patient on his sound side. Flex the thigh to an angle of 45° and adduct so as to make the trochanter prominent.

Step 1.—Make the semilunar incision A, B, C (Fig. 1158), the lowest point (B) being about 2 inches below the tip of the trochanter, the pits A and B being about the same distance in front of and behind the posterior and anterior edges of the trochanter, respectively. Divide the skin and deep fascia.

Step 2.—By means of a curved incision corresponding exactly to the skin incision, expose the base of the great trochanter. Continue this incision forwards in a curve so as to penetrate between the anterior fibres of the gluteus medius or between the gluteus medius and the tensor vaginæ femoris. Continue the incision backwards in a curve so as to penetrate between the fibres of the gluteus maximus.

Step 3.—**Method A.**—Pass a Gigli wire saw round the trochanter major and cut through the base of the trochanter from within outwards and downwards.

Method B.—With a saw cut through the base of the trochanter from without inwards and upwards (Fig. 1159).

Method C.—Make the same division with an osteotome. Whichever method is used, divide the bone obliquely so as to insure easy union.

FIG. 1157.—Kocher's operation. (*Kocher.*)

Step 4.—Reflect upwards the separated trochanter with its muscles. This exposes the joint thoroughly (Fig. 1160).

Step 5.—Treat the disease as already described.

Step 6.—If the trochanter is diseased, remove the disease or the trochanter itself, as may be indicated. If the trochanter is healthy, return it to its normal position and fix it there by sutures (wire, chromicized catgut), pegs, or screws. Provide drainage if necessary. Close the wounds. Some surgeons fill the joint cavity with iodoform emulsion, Mosetig's plug or iodoform starch and close without drainage.

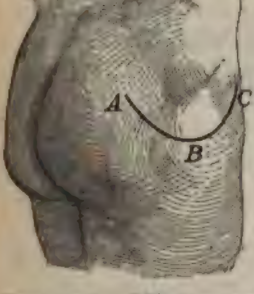


FIG. 1158.—Ollier's operation. (*Labey.*)

Rutherford Morison operates as follows: Make a convex incision immediately above the trochanter major. Divide all the muscles inserted into the trochanter. Dislocate the head of the femur through the wound. Remove all the capsule, synovial membrane, and cartilage from the head and the acetabulum. Close the wound completely. Immobilize. Do not remove the head of the femur unless it has become a sequestrum.

Remarks.—When coxitis results from osteo-myelitis the treatment ought to be by excision. While arthrotomy has given good results, yet excision leads to a quicker recovery and so avoids the more remote dangers of long-lasting suppuration (Hoffa). When there is hydrops or pyarthros, puncture and injection with some fluid such as formalin-glycerine is advisable unless there is too much absorption of toxins, in which case arthrotomy or arthrectomy is indicated. The hydrops of typhoidal coxitis demands puncture. In tuberculous coxitis when fistulæ are absent and there is no dislocation,

FIG. 1159.

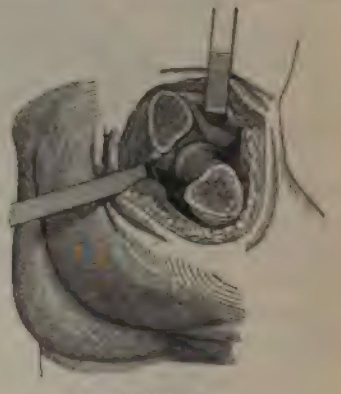


FIG. 1160.

FIGS. 1159 AND 1160.—Ollier's operation. (*Labey.*)

conservative measures ought to be thoroughly tried, especially in the young. When sequestra are demonstrated they must be removed by operation after the failure of conservative measures.

The presence of fistulæ is not *per se* an indication for radical measures, conservative means (suction hyperæmia, Beck's paste, etc.) may be tried if the symptoms are not pressing, but the attempts at conservatism must not be persisted in if improvement does not soon show itself. Even in the presence of well-marked visceral tuberculosis or of amyloid disease it is almost always proper to prefer excision to amputation in severe cases of tuberculous coxitis

Of the various methods for excising the hip the author prefers that of König.

CHAPTER LXXVIII

HIP. ARTHRITIS DEFORMANS

In cases of arthritis deformans of the hip in which there is much disability rom pain, muscular spasm, and deformity, F. H. Albee ("Jour. A. M. A.," une 13, 1908) operates as follows:

Step 1.—From a point just below and internal to the anterior superior liac spine make a 5-inch cut through the skin and subcutaneous tissue along he inner border of the sartorius.

Step 2.—Divide the deep fascia. Retract the sartorius outwards. Penerate the deep structures by blunt dissection. Retract the iliacus and rectus emoris inwards. Expose the hip-joint.

Step 3.—A large ring of osteophytes generally will be found about the rim f the acetabulum. Turn such upwards with the soft parts adherent to them. This is easily done with chisel and elevator.

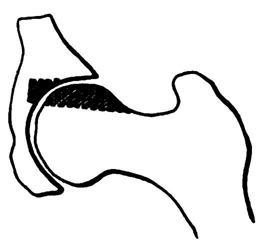


FIG. 1161.

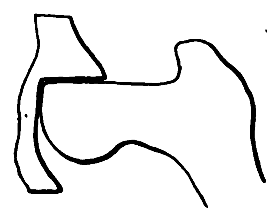


FIG. 1162.

FIGS. 1161 AND 1162.—Albee's operation.

Step 4.—Do not attempt to disarticulate the hip, but with the head of the emur remaining *in situ*, cut away about half its upper hemisphere with a large hisel in a plane nearly parallel to the axis of the femoral neck (Fig. 1161). n the same manner flatten the upper part of the acetabulum so that a flat urface of femur lies against a flat surface of acetabulum, when the limb is ablucted. Remove the chips of bone.

Step 5.—Abduct the limb and obtain approximation of the surfaces of one made flat by the chisel (Fig. 1162). The position desired is one of slight vercorrection with abduction to overcome the shortening which is always resent. Before obtaining the desired position open tenotomy of the abductors t their origins may be necessary.

Step 6.—Suture the capsule and soft parts. Apply dressings. Immobilize n a position of abduction.

Albee has used this operation in five cases with gratifying results.

CHAPTER LXXIX

ANCHYLOSIS HIP

Malpositions with bony anchylosis of the hip and certain osseous deformities, such as coxa vara, are the principal lesions which necessitate osteotomy at the hip. Bony anchylosis may be due to one of several causes—*e.g.*, tuberculous osteo-arthritis, fracture of the femur or acetabulum, etc. When choosing a method of operating, the nature of the lesion causing the deformity must be taken into consideration. An operation which would be safe in a case of anchylosis due to trauma might, in one due to tuberculosis, relight the disease process and even cause its dissemination. The choice of operation must also depend on whether the result desired is a joint immobilized in good position or one capable of movement.

I. **Supra-trochanteric Osteotomy.**—(A) **Subcutaneous with Saw. Adams' Operation** (see p. 971).

(B) **Division of the Femoral Neck with Chisel through a Small Incision.**—Place the patient on his sound side. At a point immediately above the great trochanter make a vertical incision about 1 inch long down to the neck of the femur. Introduce an osteotome alongside the knife and remove the latter. Turn the edge of the osteotome transversely to the neck of the femur and divide it completely. Do not, as in the operations for genu valgum, etc., partly divide and partly fracture the bone; this might result in dangerous splintering. Apply dressings. Immobilize the limb in good position by means of extension, splints, plaster of Paris, or by a combination of these means. Treat the case as a fracture.

Note.—Division of the neck of the femur is suitable in cases of bony anchylosis where flexion is the only deformity present. Of course when the head and neck are profoundly altered, *e.g.*, in bad cases of coxa vara or of destructive osteitis the operation is often impossible.

(C) **Open operation with introduction of muscle between the cut surfaces of the bone (Nélaton's operation)** (Huguier, Traitement des Ankyloses). Arthroplasty.

Step 1.—From a point one or two fingers' breadth below the anterior superior iliac spine make an incision through the skin and subcutaneous tissue, along the anterior border of the trochanter major. This incision is about 6 inches long. Divide the fascia throughout the length of the wound. Find the interspace between the tensor vaginæ femoris and the sartorius; separate and retract these muscles outwards and inwards, thus exposing the rectus femoris and more deeply the ilio-psoas (Fig. 1163). Strongly retract inwards these two muscles. With the finger palpate the great trochanter and the anterior surface

of the articular capsule; expose this latter completely. Split the capsule from the anterior *inferior* iliac spine to the trochanter, preserving the ilio-femoral band as well as possible. By blunt dissection denude the anterior surface of the neck of the femur and expose the junction of the head of the femur with the cotyloid cavity. (These structures are fused together.)

Step 2.—With osteotome and mallet divide the *head* of the femur where it is fused to the pelvis. Preserve as much as possible of the head of the bone attached to the neck. When the bone is divided, clean out the cotyloid cavity with gouge and rongeurs so as to make it concave and smooth. Smooth and round off the remnant of the head of the femur. If the trochanter and neck of the femur are very much deformed and are so anchylosed to the ilium that it is impossible to reform the head and neck of the bone, divide the fused mass; cut a cavity in the iliac bone; see that this cavity is provided with a prominent superior and posterior border; round off the top of the upper end of the femur so that it may fit into the above-mentioned cavity.

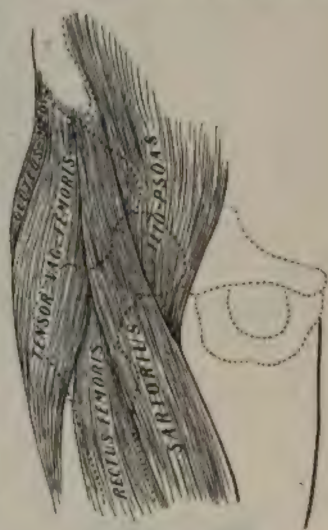


FIG. 1163.

Step 3.—The new articulating surfaces having been prepared, interpose a layer of muscle between them as follows: Divide the rectus femoris muscle about 4 inches below its origin, mobilize it, let it fall into the new-formed cotyloid cavity and fix it there with a few sutures (Fig. 1164).

Step 4.—Place the femur in position. Close the wound with or without drainage. Apply dressings and extension. Keep immobilized until the wound has healed and then gradually begin exercises.

Rochet has shown that by operating from the front the glutei muscles and the strong upper and posterior parts of the capsule are preserved intact. These structures prevent the femur from riding up over the ilium. In some cases where there is much inversion of the thigh, the anterior operation is impossible and it becomes necessary to adopt Langenbeck's or Ollier's incision for excision of the hip. The operation so far as exposing the joint is concerned is the same as in excision and requires no special notice at this place. The bones are divided and treated as in Nélaton's operation, but the muscle flap used for interposition is obtained from one of the glutei.

Murphy's Operation.—J. B. Murphy ("Journ. A. M. A.," May 20, 27; June 3, 1905), reasoning from Langemak's classical researches into the origin of bursæ ("Archiv für klin. Chir.," lxx, 946) and from some experiments of his own, concludes that fascia and fat are more suitable than muscle for interposition between the ends of the bone after section. In the case of a school boy Murphy operated as follows and obtained a brilliant result:

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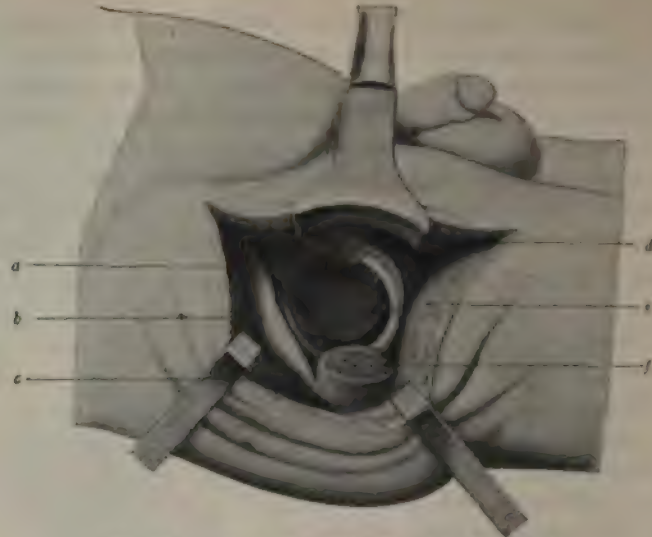


FIG. 1164.—Nelaton's arthroplasty. (*Huguier.*)
a, Flap of rectus muscle; *b*, ilio. femoral band; *c*, tensor fasciæ latæ; *d*, sartorius; *e*, neck of femur.

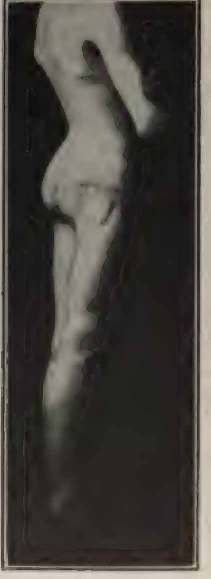


FIG. 1165. FIG. 1166.
FIGS. 1165 AND 1166.—Result of arthroplasty. (*Murphy.*)

Step 1.—Make a V-shaped incision, with the trochanter in the centre of V, reaching from a point 4 inches above to a point 2 inches below the tro-nter. The open end of the V is 5 inches wide and directed upwards. Reflect vards the V-shaped flap containing skin, superficial fascia, and fascia lata gs. 1165 and 1166).

Step 2.—With a needle and guiding suture, pass a Gigli wire saw round base of the trochanter major and divide it transversely. This may be e with an osteotome. Turn the severed trochanter with its attached scles upwards (Figs. 1167, 1168 and 1171).

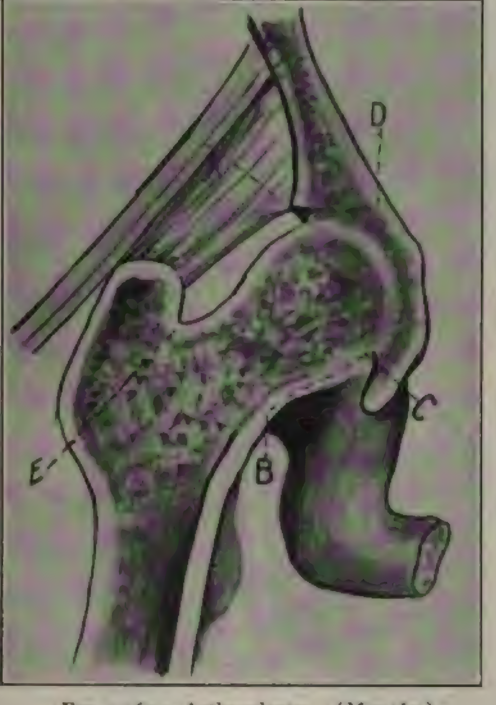


FIG. 1167.—Arthroplasty. (*Murphy.*)

Step 3.—Incise the articular capsule and separate it from the ilium all the y round.

Step 4.—Chisel the bony material (head of femur and new bone) filling the tabulum from the latter, beginning at their line of junction and so cutting t as much as possible of the femoral head is retained (Fig. 1172 and 1176). er cutting most of the line of union, the remainder may be fractured by ving the thigh.

Step 5.—With chisel, rongeurs, and scoop, smooth and deepen the cotyloid ity. Similarly round off and smooth the head of the femur.

Step 6.—Dissect the fascia lata from the rest of the original V-flap leaving base intact. With this fascial flap, line the new cotyloid cavity. Fix the

new lining in position by a few sutures. Only a part of the flap and that near its base is required for this purpose, the apical portion will be used to cover the femur. By manipulations return the head of the femur into the socket (Fig. 1168). Suture free margin or apical portion of the fascial flap to the periosteum and capsule attached to the neck of the femur. This is important, as Murphy considers it essential that every part of the new articulating surfaces be covered with fascia.

Step 7.—Peg or wire the divided trochanter major in its old position. Close the wound. Dress and apply extension.

Fig. 1168.—Arthroplasty. (*Murphy.*)

N. B.—It may be necessary to perform tenotomy on one or several muscles and so overcome their contraction before a good position is obtained. (Figs. 1165, 1166 and 1177 show the result in a case of Murphy's.)

The series of illustrations published by Guillot and Dehelly (J. de Chir., March, 1914) are so much more illuminating than words or than Murphy's own figures that they are included here and may almost take the place of the description in the text. Figs. 1169 to 1175.

II. **Trochanteric Osteotomy.**—Rhea Barton (Philadelphia) was the first to correct deformity in hip anchylosis by osteotomy. His line of section was through the trochanter major (Fig. 1178). This operation is not performed now.

III. **Intertrochanteric Osteotomy.—Sayre's Operation.**—*Step* 1.—Make a vertical incision from a point just above the tip of the great trochanter

FIG. 1169.—Skin reflected. Facial flap outlined. (*Guillot and Dehelly, J. de Chir.*)

FIG. 1170.—Division of trochanter major. (*Guillot and Dehelly, J. de Chir.*)

FIG. 1171.—Trochanteric muscles reflected upwards. Joint opened. (*Guillot and Dehelly, J. de Chir.*)

FIG. 1172.—Separation of anchylosed bones. (*Guillot and Dehelly, J. de Chir.*).

FIG. 1173.—Reaming acetabulum. (*Guillot and Dehelly, J. de Chir.*)

FIG. 1174.—Facial flap made to line acetabulum. (*Guillot and Dehelly, J. de Chir.*)

FIG. 1175.—Mobilized trochanter replaced and nailed. Suture of divided structures. (*Guillot and Dehelly, J. de Chir.*)

downwards for 6 inches along the mid-line of the outer surface of the femur. From the middle of this incision make a transverse cut directly backwards for a short distance.

Step 2.—Expose the anterior, outer, and posterior surfaces of the upper end of the femur by means of the periosteal elevator until the trochanter minor can be felt.

Step 3.—Pass a chain or Gigli wire saw around the femur between the major and minor trochanters. (a) Make a Λ or Ω-shaped section of the bone (Fig. 1179). Divide the upper end of the lower fragment transversely, removing a segment of bone one-eighth of an inch thick at its outer and inner margins. With chisel and forceps round the upper end of the lower fragment so as to fit into the cavity in the upper fragment.

Step 4.—Close the wound and treat as a compound fracture. Sayre's object was to obtain a mobile joint, but one can hardly expect much success from the original operation. The author suggests the following modification of the Sayre method:

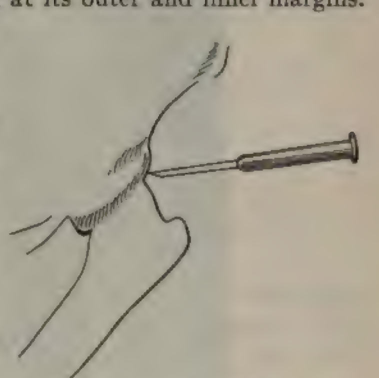


FIG. 1176.—Anchylosis of hip.

Step 1.—Make a **V**-shaped incision having the trochanter midway between its anterior and posterior limbs, reaching from immediately above to a point about 5 or 6 inches below. The open end of the **V** incision is directed upwards and the distance between the two vertical portions of the **V** is about 2½ to 3 inches. Reflect upwards the **V**-shaped flap which must consist of skin, subcutaneous tissue, and fascia lata (as in Murphy's operation).

Step 2.—Pass a Gigli wire saw around the femur between the two trochanters and divide the bone transversely (the division may be made with an osteotome).

Step 3.—With a gouge and rongeurs excavate a bowl-shaped depression in the mass of fused bone (trochanter major, head and neck of femur and ilium) which represents the anchylosed hip.

Step 4.—Separate the fascia lata from the reflected **V**-shaped flap, leaving it attached by its base. With this flap line the new-made cotyloid cavity.

Step 5.—With rongeurs, etc., round off the upper end of the lower fragment of femur and fit it into the new cotyloid cavity.

Step 6.—Close the wound. Apply dressings and extension. When the wound is healed begin motion.

IV. **Subtrochanteric Osteotomy.**—Advantages over the supra- or intertrochanteric operation: (*a*) Ease in performance. (*b*) Remoteness from articulation (important in tuberculous disease). (*c*) Section is below insertion of the psoas muscle. If this muscle could act on the lower fragment it might cause recurrence of the mal-position.

(A) **Transverse Linear Subtrochanteric Osteotomy (Gant's Operation).**—*Step* 1.—At a point four fingers' breadth below the tip of the great trochanter

over the external surface of the femur make a vertical incision down to the bone. The incision must be of sufficient length to permit the easy introduction of an osteotome.

Step 2.—Introduce the osteotome with its cutting edge parallel to the wound, when the osteotome reaches the bone, turn it so that its cutting edge becomes transverse to the long axis of the bone. Cut through the bone as in supracondyloid osteotomy (Fig. 1180).

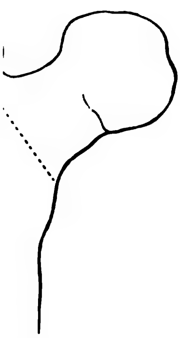
FIG. 1177.—Arthroplasty. (*Murphy.*)

Step 3.—Remove the osteotome. It is usually unnecessary to insert sutures. Place the limb in good position. Apply dressings and extension.

N. B.—The bone section may be made with an Adams' or Jones' saw instead of with an osteotome.

(B) **Oblique Linear Subtrochanteric Osteotomy (Terrier, Hannequin).**—*Step* 1.—Make a vertical incision 5–6 inches in length along the middle of the outer surface of the femur from the top of the trochanter major downwards. Separate the periosteum from the bone over its anterior and external surfaces corresponding to the line of section of the bone.

2.—With an osteotome or chisel, cut a groove across the outer surface femur immediately below the great trochanter. This groove prevents ; of the osteotome when the oblique section is begun. Using this groove ırting-point, divide the bone obliquely from above downwards and in-



178.—Rhea Barton's osteotomy.

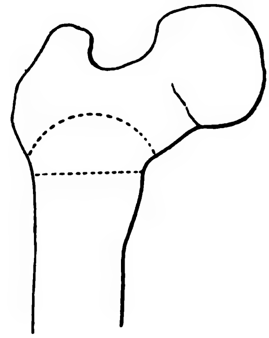


FIG. 1179.—Sayre's osteotomy

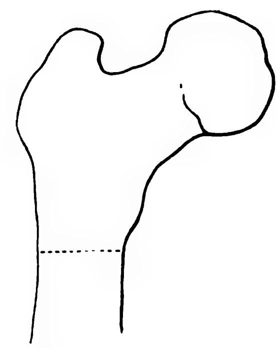


FIG. 1180.—Gant's osteotomy.

The antero-posterior plane of section ought not to be exactly straight, ʒht to be slightly oblique from in front backwards and inwards. This etter apposition of the fragments when extension is applied (Figs. 1181 82).

FIG. 1181.

FIG. 1182.

FIGS. 1181 AND 1182.—Oblique osteotomy. (*Hoffa.*)

: advantage to be gained from the obliquity of section is that, when shortening of the limb is present, extension may cause the divided sur-) slide on each other, and thus give some lengthening while the fragments nain in apposition.

(C) **Linear Oblique Trochanteric Osteotomy (Berger's Operation).**—The operation is almost identical with the preceding, but the line of section is as shown in Figs. 1183, 1184. The technic of Berger's operation is difficult

FIG. 1183.

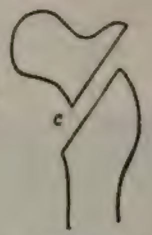


FIG. 1184.

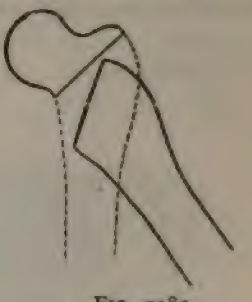


FIG. 1185.

FIGS. 1183, 1184 AND 1185.—Oblique trochanteric osteotomy. (*Jones.*)

but the use of Jones' saw greatly simplifies it as the hook at the end of the blade prevents transfixion of the tissues and also prevents the saw escaping from its groove in the bone. Robert Jones has frequently performed this operation with complete success in cases where besides flexion there was much

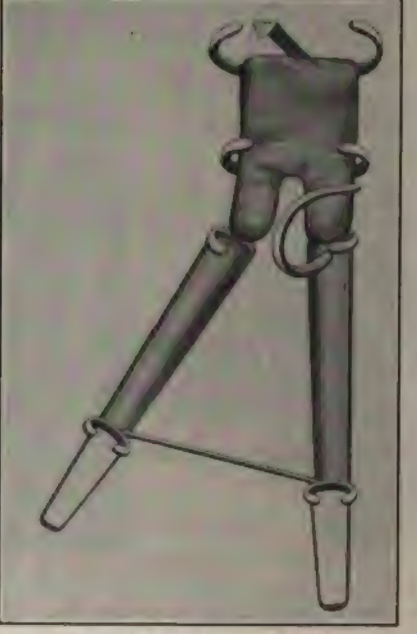


FIG. 1186.—Abduction splint. (*Jones.*)

adduction with pelvic tilting. After dividing the bone he cuts the adductors subcutaneously and in the case of a youth or adult applies traction by means of pulleys. By this traction an inch or more of *true* lengthening may often be

'ig. 1185). After applying proper dressings he places the leg in an splint (Figs. 1186 and 1187), which is arranged so as to keep up the The degree of abduction desired depends on the amount of short- f pelvic tilting, *i.e.*, the amount of true shortening. Fig. 1188 shows ' *abduction* may, by tilting of the pelvis, give apparent lengthening shortened limb. The patient must be kept in the splint for seven or s or until bony union is complete. Jones, following his uncle, nas, and Rushton Parker, does not fear dividing the bone through ssue when this is necessary. After bony union is secured and the ved the limb should be allowed to leave the abducted position slowly, e should be prescribed to depress the pelvis on the affected side and *pparent* lengthening of the short limb.

FIG. 1187.—Abduction splint. (*Jones.*)

neiform Subtrochanteric Osteotomy.—*Step* 1.—Make a 2- to 3-inch cision over the external surface of the femur, having its middle about four fingers' breadth below the tip of the trochanter major. edges of the wound and reflect the periosteum over an area involving f the bone.

—With chisel and mallet excise a wedge of bone. The wedge must e so placed as to correct the deformity, *e.g.*, if there is a deforming exion the base of the wedge must be on the posterior surface of the rrect adduction the base of the wedge must be external (Fig. 1189). tion of cuneiform is trapezoidal osteotomy and is sufficiently ex- Figs. 1190 and 1191.

Step 3.—Straighten the bone. Introduce a few sutures. Apply dressings. Immobilize.

Whitman advises cuneiform osteotomy at the level of the lesser trochanter in young children with coxa vara. He writes: "In childhood the neck of the femur is short and the strain to which it is likely to be subjected slight, thus operative treatment may be indicated as a prophylactic measure while in adolescence operative treatment may be deferred until the progression of the de-

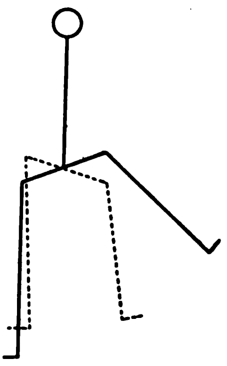


FIG. 1188.—Diagram showing how abduction gives apparent lengthening to a limb.

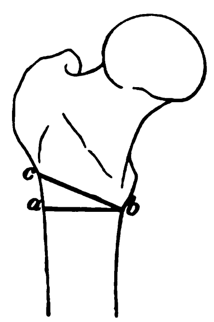


FIG. 1189.—Cuneiform subtrochanteric osteotomy. (*Berger and Banzet.*)

formity has ceased. In the technic of this procedure there are several points of importance. First, all restriction of adduction of ligamentous or muscular origin, must be overcome by vigorous manipulation before the operation on the bone, otherwise it will be difficult to bring the two fragments into proper apposition. The base of the wedge should be about three-quarters of an inch in breadth, directly opposite the trochanter minor; the upper section should be practically at a right angle with the shaft, the lower being more oblique (Fig.

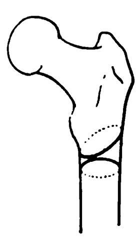


FIG. 1190.

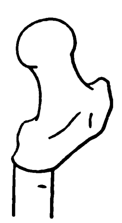


FIG. 1191.

FIGS. 1190 AND 1191.—Trapezoidal osteotomy. (*Berger and Banzet.*)

1192). The cortical substances on the inner aspect of the bone should not be divided, but, reinforced by the cartilaginous trochanter minor, should serve as a hinge on which the shaft of the femur is gently forced outwards, until the opening is closed by the apposition of the fragments after the upper segment has been fixed by contact with the margin of the acetabulum (Fig. 1192), thus

the continuity of the bone is preserved. The leg is then held in the attitude of extreme abduction, by means of a plaster spica bandage, which should include the foot also, until the union is firm.

"The opportunity for treatment of coxa vara, in earliest childhood, is rarely offered. It is usually the direct result of rachitis, and in the early stage, at least, it is probably accompanied by other rachitic distortions. It would be well, therefore, to examine the hip-joints of rachitic children, especially those who present the deformity of genu valgum with reference to this distortion."

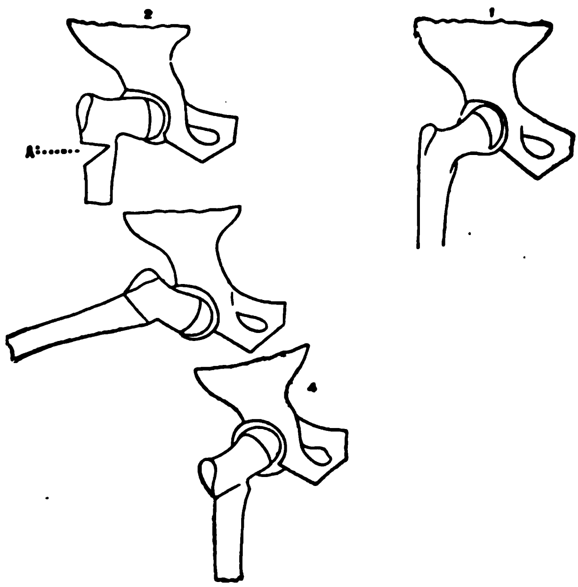


FIG. 1192.—Whitman's operation. (*Whitman.*)

Jones's Operation.—In bony anchylosis of the hip following tuberculosis or sepsis and in certain forms of coxitis, *e.g.*, malum coxa senilis, where the body weight acting on the head of the bone, and articular friction keep the disease active, Robert Jones produces a pseudo-arthrosis without disarticulating the head of the femur. The operation produces much less shock than does excision of the head of the bone and in suitable case has given excellent functional results.

Step 1.—Make a 6-inch longitudinal incision along the outer surface of the upper end of the femur. One-half of the incision is above the mid-point of the upper border of the trochanter major and one-half is below. This cut in its lower half penetrates to the periosteum or bone. Retract the soft parts.

Step 2.—Incise the periosteum transversely at the base of the trochanter just below the insertion of the gluteal muscles. From this line cut through the trochanter to its junction with the femoral neck, using a saw or a wide osteotome (Fig. 1193). Retract the separated trochanter upwards.

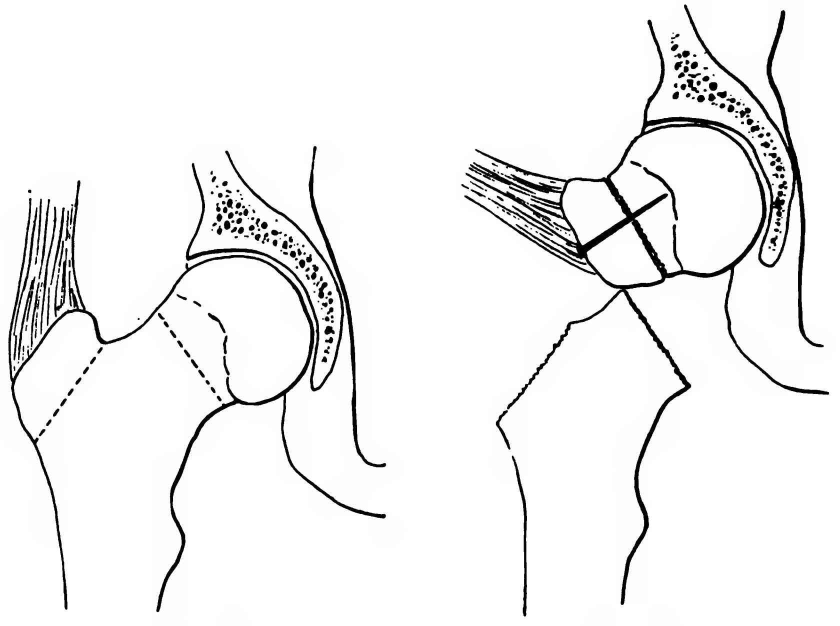


FIG. 1193. FIG. 1194.

FIGS. 1193 AND 1194.—R. Jones' operation. (*Jones.*)

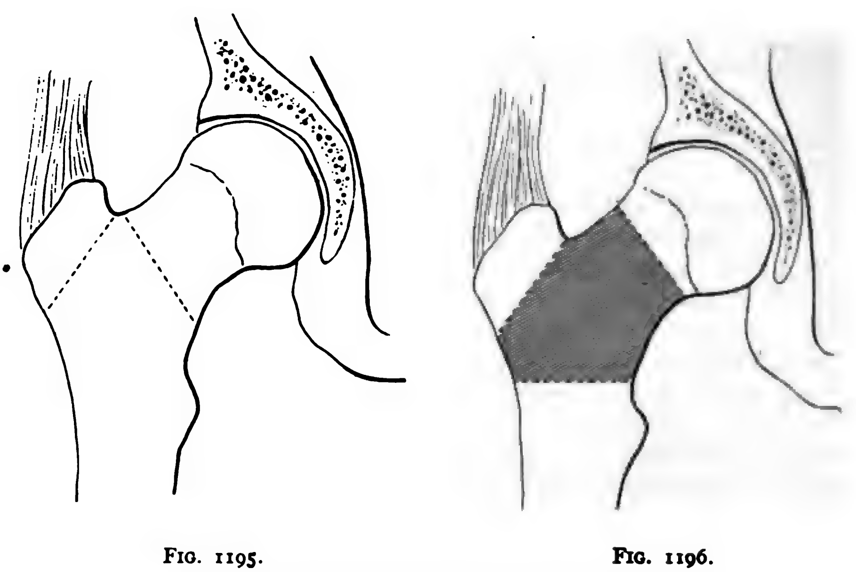


FIG. 1195. FIG. 1196.

FIGS. 1195 AND 1196.—R. Jones' operation. (*Jones.*)

Step 3.—Open the joint. Divide the neck of the femur near the head of the bone with an osteotome (Fig. 1193).

Step 4.—Exert strong extension on the femur. Apply the cut surface of the separated trochanter to the cut surface of the neck of the femur and fix it there with a screw nail (Fig. 1194). This fixes the trochanter to the head of the femur which is still in the acetabulum.

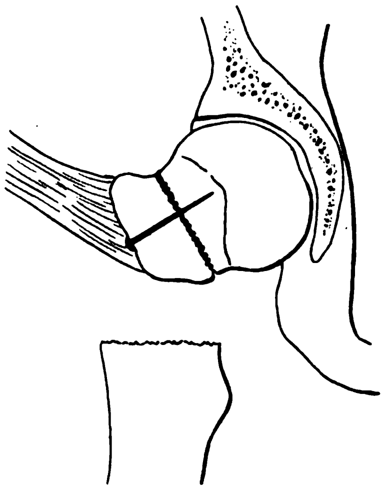


FIG. 1197.—R. Jones operation. (*Jones.*)

Step 5.—Close the wound with deep and superficial sutures. When there is much tenderness it may be necessary to remove a section of the neck instead of merely dividing it, so as to avoid "impinging." "In the case of an anchylosed sound joint following sepsis it may be advisable, instead of dividing the neck near the acetabulum, to divide it near the trochanter (Fig. 1195)." Where there has been much injury due to disease more bone may be removed as shown in Figs. 1196 and 1197.

CHAPTER LXXX

OLD DISLOCATIONS OF THE HIP

When a dislocation of the hip has remained unreduced for a few weeks it has become practically irreducible by manipulation alone. Even recent dislocations may resist manipulative reduction. The principle conditions or lesions preventing reduction are: (*a*) The filling of the cotyloid cavity with fibrous tissue which often becomes osseous. (*b*) The interposition between the femur and the acetabulum of shreds of capsule, fascia, muscle, etc., to which may be attached fragments of bone torn from the trochanter or broken off the rim of the acetabulum.

(*c*) Changes in the shape of the head of the femur due to its adaptation to new surroundings, also fixation of the femoral head in a new-formed acetabulum.

(*d*) The femoral head may be grasped tightly in a collar formed by the small external rotator muscles.

(*e*) The muscles, ligaments, and fascia surrounding the dislocated bone adapt themselves to their new conditions, hence they are contracted or shortened in places and so obstruct reduction.

(*f*) Fractures of the head of the bone and even of the shaft seriously interfere with reduction.

I. **Posterior Dislocations.—Method A.**—*Step* 1.—Make a 5-inch incision over the region of the acetabulum along the posterior portion of the trochanter major (Fig. 1198). Divide the tissues attached to the posterior margin of the trochanter; while doing this hug the bone.

Step 2.—Expose and clean out the acetabulum. If necessary for reduction remove the parts of posterior wall of the acetabulum with chisel or rongeurs. This assists reduction and provides for drainage.

Step 3.—Loosen the head of the femur from its surroundings by manipulation, by blunt dissection, and, if necessary, by sharp dissection.

Step 4.—Reduce the dislocation by manipulation of the limb and by direct pressure, etc., on the head of the bone.

Step 5.—Provide for drainage. Close the wound. Dress. Apply extension. While operating remember that the great sciatic nerve is sometimes picked up by the dislocated femur and passes as a tight band over the neck of the bone (Fig. 1199) and is thus in distinct danger.

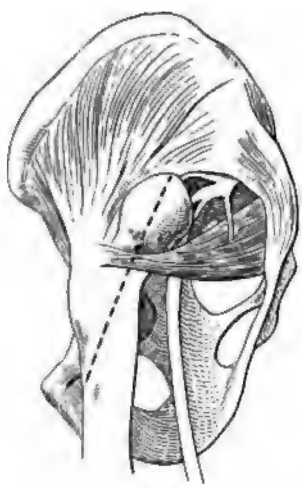
Method B.—A. von Bergmann ("Archiv für klin. Chir.," lxix, 592) advises the use of Larghi's incision in cases of the old hip dislocation whether traumatic or congenital in origin.

Step 1.—Make an incision parallel to, and immediately below the crest of the

om the posterior inferior, past the anterior superior spine to the anterior spine between the tensor vaginæ femoris and sartorius muscles. This the origin of the gluteus maximus and medius.

2.—Corresponding to the skin incision, divide the gluteus maximus, and minimus close to their origin, but preserve the periosteum until the he sciatic notch is reached; at this level divide the periosteum and reflect lownwards along with the overlying soft parts (this preserves the superior artery from injury). Continue the dissection or separation downwards osteally until the acetabulum is well exposed.

3.—After exposure of the acetabulum, separate the soft parts from both iters by division, under guidance eye, of the muscular insertions. this various manipulations of gh are necessary so as to make ent the dislocated head of the



1198.—Exposure of dislocated hip. (*After Hoffa.*)

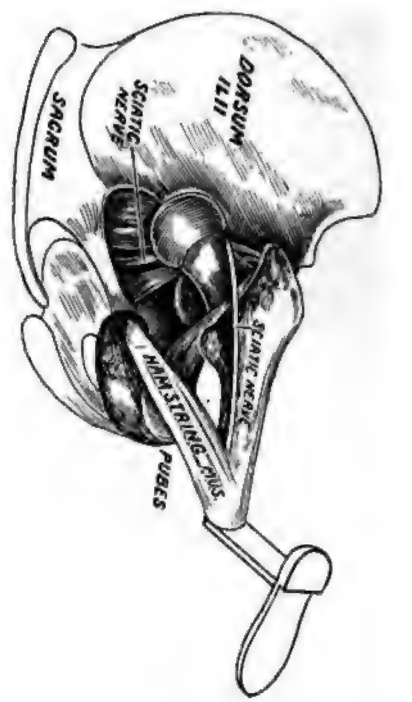


FIG. 1199.—Posterior dislocation of hip. Sciatic nerve stretched over neck of femur. (*Allis.*)

4.—Examine the acetabulum. If necessary prepare it for the reception iead of the femur. By manipulation and traction reduce the dislocation. s tenotomies may be necessary to permit of reduction.

5.—Close the wound with or without drainage. Dress.

thod C.—Cheyne and Burghard recommend anterior arthrotomy. M. ris uses the same route. In one case Spencer found that it would have npossible to reach and clear the acetabulum through a posterior incision t resecting the head of the femur.

1.—Make a 4-inch incision downwards and forwards from just beneath

the anterior superior spine and between the tensor vaginæ femoris and the sartorius.

Step 2.—Separate the above-mentioned muscles and so expose the region of the head and neck of the femur. "In order to get satisfactory access to the acetabulum, it will generally be found necessary to detach some of the muscles from the ilium. Division of the tensor vaginæ femoris and the anterior part of the gluteus minimus may be necessary, as they will probably be somewhat shortened."

Step 3.—Incise the joint capsule near its insertion into the neck of the femur. Divide the Y-ligament and obstructive bands. Clean out the acetabulum.

Step 4.—Reduce the dislocation. It may be necessary to divide the tendon of the obturator internus before success is attained. Close the wound without drainage if hemostasis is complete and asepsis assured; if necessary posterior drainage may be provided.

After-treatment.—Whatever method of operating is chosen, extension by weight and pulley should be applied. At an early date begin gentle passive motion. As soon as the wound has nearly healed, change the direction of the extension from day to day; *e.g.*, at first the extension is directly in the line of the body, change it so that the hip is slightly flexed, then make the extension in such a manner that there is a little abduction, and so on, changing the position slightly every day. Passive movements must be employed daily, unless signs of inflammation are present in the wound. At as early a period as possible after healing of the wound is complete, active movements should be initiated. Too much importance cannot be placed on thorough after-treatment.

II. **Anterior Dislocations.**—Perhaps the most practical way to describe the operative reduction of anterior dislocations will be to give a résumé of a case operated on and reported by Endlich ("Archiv für klin. Chir.," lvi, 585). Male, thirty-seven years of age. Obturator dislocation of three months' duration. Incision along the lower (posterior) edge of the gracilis from the symphysis pubis downwards. The head of the femur was reached after the abductors were penetrated. The femoral head lay in a very firm capsule of fibrous tissue containing many fragments of bone.

Owing to the depth of the wound and density of tissues the bone could not be freed sufficiently. The patient was turned on his right side. Langenbeck's incision, six inches long, was made, beginning below the trochanter major and running upwards and backwards towards the *portesios* superior iliac spine. After penetration of the gluteal muscles the acetabulum was reached and found filled with firm fibrous tissue which was removed. The femoral head lying in front of the acetabulum was freed from the adherent soft parts by blunt and sharp dissection. Much scar tissue containing shell-like fragments of bone was removed. After removal with the chisel of a portion of the anterior edge of the cotyloid cavity opposite the femoral head, reduction by manipulation was successful. Both wounds were loosely packed with gauze. Dressings and extension applied. The result was at first disappointing, but poverty forcing the patient (a laborer) to work, his hard labor proved the best after-treatment and the outcome was

ıost gratifying. In such a case as the above it probably would be better to mit the first (internal) cut made by Endlich and content one's self with the angenbeck incision.

Dislocation of the Hip Complicated by Fractures.—Fracture of the shaft f the femur complicating dislocation may hinder reduction by preventing the se of the bone as a lever, and thus compel operation.

When there is extra-capsular fracture of the neck of the femur, expose the one, if possible reduce the dislocation, and then treat the fracture *secundem rtem* (preferably by the application of a buried metal splint). If reduction of ıe dislocation is impossible or improper, the separated head of the bone may excised, or if it is causing no pressure symptoms and will apparently not inrfere with the ultimate result it may be left *in situ*, the surgeon aiming to tain a useful pseudarthrosis.

Intracapsular fracture complicating dislocation usually calls for excision the head of the bone.

When operative reduction is impossible or seems too severe a tax on the tient, excision of the head of the bone may be indicated. Osteotomy may practised instead of excision. The aim of this operation is to correct disling deformity and it may be performed in such a fashion as to provide a new int (see Osteotomy). Reduction when proper is of course the operation of oice. Excision is preferable to osteotomy when the displaced bone is causing mptoms, *e.g.*, pain and paralysis from pressure. Osteotomy may be preferle in the absence of the above troubles and when it is doubtful if the patient's rength is equal to the strain involved in the operation of excision, and when sabling deformity is present resulting from the malposition. Sometimes ıe malposition may be corrected to a practical extent by non-operative treatent. This is well worth trying. When the dislocated head is not causing essure symptoms and when after exposure reduction is impossible, it is not ways necessary to excise the head of the bone. "The best thing is probably try and form a new acetabulum upon the iliac bone, in the new position that ıe head of the bone occupies, and to so substitute a stable and movable joint r the unstable and useless one resulting from the dislocation. To do this a ortion of the pelvis is gouged away opposite the head of the bone until a ıallow bed is formed in which the head can lie. Instead of removing the ortions of bone so raised, it is well to simply gouge them upwards and then bend ıem at right angles to the pelvis, so that they form a sort of buttress, preenting the head of the bone being pulled farther up. In the course of a few eeks considerable callus is thrown out around the portions of bone detached this way, and thus an obstacle to the further dislocation of the head is otained" (Cheyne and Burghard).

CHAPTER LXXXI

CONGENITAL LUXATION OF THE HIP

GWILYM G. DAVIS

There are some affections which, without doing special harm, the practising physician or general surgeon can deliberately ignore and relegate to the care of the specialist, but a congenital luxation of the hip is not one of them. Although the treatment can be intrusted to the specialist, it is incumbent on those who first see these cases to recognize their serious character, and this in too many cases they fail to do. The affection is a frequent one; its manifestations are obscure, especially in its early stages; untreated it never undergoes spontaneous cure, but progressively gets worse, deforming and even disabling the patient. Failure to recognize the affection and delay in instituting treatment increase the difficulty of remedying it and may even render the patient a permanent and more or less helpless cripple. For these reasons the general physician and surgeon should have a sufficient knowledge of it to enable him to suspect and possibly diagnose its presence and inform the parents as to the course to be pursued in having it properly treated.

Etiology.—The cause of this affection is unknown. In some cases the luxation is produced at the time of birth, but few, however, can be accounted for in this manner; in some heredity seems to play a part; intra-uterine disease has also been held to be a factor, but this has not been generally accepted. Retarded development does not account for it. Perhaps the most favorably received theory is that the luxation is the result of slowly acting force exerted during intra-uterine life. This is supposed to occur in cases in which there is a lack of amniotic fluid, thus allowing the uterine walls to act more directly and forcibly on the extremities. Codivilla states that they are flexed, adducted and rotated inwardly. This condition existing for a considerable time destroys the stability of the joint and favors anatomical changes; the capsule becomes relaxed, the acetabulum shallow and the upper end of the femur altered. The preponderance of the affection in females—six or seven to one—is explained by the sexual anatomical differences in the pelvis, which begin to manifest themselves as early as the fifth month of intra-uterine life.

Prognosis.—Some surgeons appear to consider congenital luxation of the hip as not a very serious affection, but with this we cannot agree. It is deforming, painful, disabling, and greatly interferes with the patient's usefulness and ability to earn a livelihood. The affection is least marked at birth. There is no pain and usually it is only when the child begins to walk that the trouble is recognized. The gait of a one-sided luxation is a marked limp; of a double, a distinct waddle. Soon the back becomes hollow. Perhaps for several years

the patient may go about in this condition, deformed and limping, somewhat disabled but still fairly active. As age advances the displacement becomes more marked. Pain, in various degrees, is experienced. Difficulty is found in going up and down stairs and walking long distances is impossible. After puberty a rapid increase is noted and if compelled to earn their livelihood these patients try to obtain a sitting occupation. Even then they are sufferers, and from time to time, at least temporarily, are compelled to rest in bed. While there may be intervals when they are free from pain, still they are liable to be disabled at any time, and so they pass a more or less miserable existence. If pain is at all constant it prevents them from taking a sufficient amount of exercise and this with advancing years causes them to take on fat and increase in weight which all tends to aggravate their distress, and their condition often becomes pitiable.

FIG. 1200.

FIG. 1201.

Anatomy.—The bony changes are marked. The acetabulum (Fig. 1200) is less in size than normal, it loses its round form and becomes narrowed at the sides, thus making it longer vertically than in its horizontal axis. The cartilage becomes thicker, thus reducing the depth of the acetabulum and the fat and fibrous tissue from the region of the cotyloid notch encroach upwards and also help to fill it up. The cartilaginous rim, especially above and posterior, atrophies and this together with the filling up of the acetabulum by the fatty and fibrous tissues practically, in many cases, obliterates the concavity; hence when the head is replaced it frequently reluxates. Sometimes masses of cartilage and bone are found in the acetabulum in operative cases; these are considered by Lorenz to be out-growths from the posterior wall.

The acetabular changes are frequently found at birth, though they increase with age. In old cases, sometimes, more or less bony out-growths and hollows exist above the acetabulum, which tend to make the articulation more firm and secure.

The femur, also, at its upper extremity (Fig. 1201), while somewhat deformed at birth, is still more deformed as age advances. The head is smaller than normal and flattened on its inner posterior portion. In some cases it is more or less pointed while in others it is markedly flattened, having a somewhat mushroom-like shape. The neck shortens, and its angle with the shaft decreases from 130° frequently to a right angle. It also becomes anteverted from the 10° or 15° of normal to almost or quite 90°. In extreme cases it may even point anteriorly instead of inwardly.

The pelvis, while at birth nearly normal, as years progress becomes distorted; it, too, is atrophied. The true pelvis is enlarged, especially in its transverse diameter, the subpubic angle is increased, the promontory of the sacrum more projecting, and the tuber ischii wider apart. In one-sided luxations the asymmetry is marked, one side being distorted while the other is more nearly normal. The pelvis tilts downwards, lordosis is marked, and the abdomen protrudes. These conditions with the accompanying distortions sometimes give rise to difficulties in parturition, but not frequently.

The capsule is stretched and, being compressed between the head and side of the ilium, it may fuse or become united with the periosteum beneath. The outer side of the capsule is stretched across the acetabulum and in rare cases is fused with the fatty fibrous mass occupying it. Between the original acetabulum and the head of the bone the capsule may be contracted, making the joint cavity hour-glass shape. The ligamentum teres, while present at birth, soon atrophies. In rare instances it is thickened, but usually it is small in size or even lacking. When it persists it is found as a long, flat ribbon-like strand (Fig. 1200). Shortening of the muscles was formerly regarded as the greatest obstacle to reposition, and the cutting operations were largely founded on this supposition. The head being above and posterior to its normal position, it is evident that the muscles going up and back from the region of the trochanters, *i.e.*, the glutei will be somewhat shortened, also the muscles going down anteriorly from the pelvis to the femur, particularly the adductors; but this shortening is of little practical moment, because it is readily overcome in the manipulations used in reduction without the necessity of especially rupturing them, as does Lorenz, or dividing them, as did Broadhurst, Hoffa, and others.

Symptoms and Diagnosis.—The history is that of a congenital affection, not an acquired one, and an absence of traumatism. This aids in excluding hip disease and coxa vara. A marked limp appearing when the child begins to walk is usually the first thing noticed and causes a physician to be consulted. With the limp is associated a sinking of the trunk and a rolling motion, which in bilateral cases produces a distinctly waddling gait. It is peculiar and markedly different from that due to coxalgia, coxa vara, or simple shortening, but resembles more that of paralysis. It is usually marked from the time the child begins to walk and may vary in degree at different periods of life. Pain is often lacking in young children but they frequently tire readily, and, as the patient grows older, it may become so distressing as to necessitate confinement to bed for considerable periods of time. The affection is best diagnosed by its

l signs. It should be remembered that the head of the femur is above ıally behind the acetabulum. This tends to make the trochanter of the l side prominent. In a unilateral luxation this may be somewhat con- ͻy an inclination of the trunk towards the affected side, but in double ıs (Fig. 1202) it is sufficiently marked to widen the space considerably the perineum from one thigh to the other. In unilateral luxations ɪo3) the tilting of the trunk towards the affected side will be evident. ; no turning inwards of the foot such as is present in traumatic luxations. from the side there will be seen a hollowness of the back (Fig. 1204), , due to the tilting of the pelvis forward and an accompanying promi- ɔf the buttocks. In unilateral cases a twisting of the pelvis may be

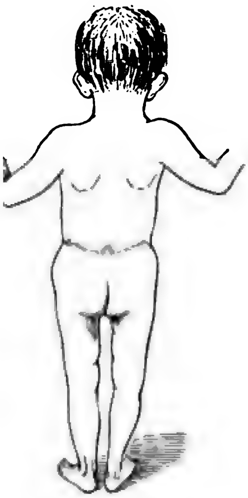


FIG. 1202.

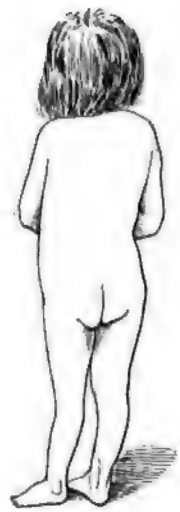


FIG. 1203.

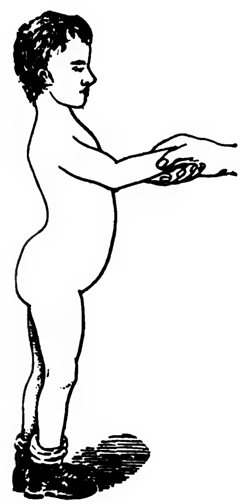


FIG. 1204.

ble, and in order to compensate for the shortening of the affected limb ›osite one may be slightly flexed both at the hip and knee. A tendency ͻn of these joints exists also in the affected limb and particularly so in er cases of double luxation; when the patient stands upright, flexion of ps and knees may be marked. This is due to the tilting of the pelvis ls.

ʀed posteriorly the increased breadth across the pelvis from one trochan- the other is noticed (Fig. 1202); the trochanters are prominent and the : beneath flattened. In unilateral luxation the gluteo-femoral fold of the l side is lower than that of the sound side, and the trunk is also inclined ; the affected side. Trendelenburg has pointed out that if the child on the sound leg and flexes the affected one the lines of the folds of the :s will remain nearly level (Fig. 1205), whereas if it stands on the affected ıd flexes the sound one the gluteal fold on the sound or flexed side will This is due to the increased tilting of the pelvis in the latter case.

On more closely examining the patient it will be found that by actual measurement in unilateral cases there will be a shortening on the affected side which is considerable and in old cases may amount to one and a half to two inches. It is rendered apparent by adopting Allis's procedure of having the patient flat on the back and flexing the knees and hips to a right angle, the knee of the sound side will be seen to project far above that of the affected side (Fig.

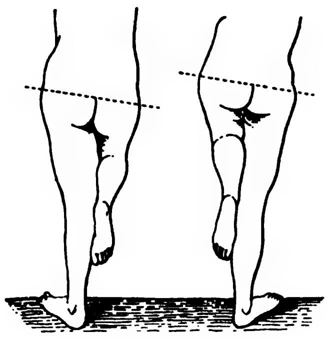


FIG. 1205.

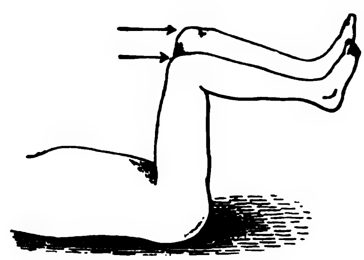


FIG. 1206.

1206). If the patient is seated on a chair in front of the examiner one knee can be both seen and felt to be considerably in advance of the other. To determine the location of the shortening it is necessary to compare a bony landmark of the femur with one on the pelvis. For this purpose the upper edge of the greater trochanter and the anterior superior spine of the ilium are used. If the measured distance from the tip of the greater trochanter on one side to the corresponding external malleolus is the same as that of the opposite side while the distances from the anterior superior spine to the internal malleolus on the two sides differ, it is evident that the cause of this difference is located above the greater trochanter and that it lies higher than normal. This may be due to either dislocation, fracture, or disease affecting the head and neck of the bone. Normally, the upper edge or tip of the greater trochanter lies almost exactly on a line drawn from the anterior superior spine to the tuberosity of the ischium—Nélaton's line (Fig. 1207). In congenital luxations, the upper edge of the trochanter is considerably above it, proportionate to the amount of shortening. Normally, the upper edge of the trochanter lies obliquely downwards and backwards from the anterior superior spine, but in these luxations it is usually opposite the level of the anterior spine and sometimes above it. What may be called the iliotrochanteric angle is lessened or even abolished. The position of the head of the bone should be identified. Normally, it can be recognized lying beneath the femoral artery just below

FIG. 1207.

igament. The artery crosses the femoral head a little internal to its ;. 1208). If the hip is grasped between the thumb anteriorly and teriorly, the thumb being just external to the artery, by rotating he head can be felt moving under the thumb. In luxations the placed posteriorly, upwards and outwards. So deep is it that it is ly recognized by the fingers which are posterior than by the thumb terior; this is especially the case when the limb is markedly rotated The range of motion of the luxated hip is increased in adduction decreased in abduction. The lessened abduction is usually not so in coxa vara (a lessening of the angle between the neck and shaft), some cases a condition of coxa vara may be present in which case would be markedly restricted. Adduction may be so much increased

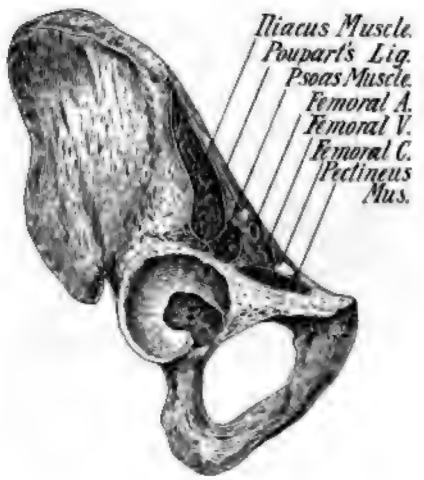


FIG. 1208.

the thigh of the affected side to be brought across the groin of the le.

seness of the joint may be demonstrated with the child lying on the ig its limbs either extended or flexed. If the limb to be examined is he surgeon grasps the two sides of the pelvis with his hands to fix it. pected side the thumb is placed on the anterior superior spine while inger touches the top of the greater trochanter. An assistant now leg and alternately pulls it down and pushes it up. If the hip is greater trochanter will be felt sliding up and down.

ining the limb in a flexed position (Fig. 1209), a method valuable in e knee is grasped with one hand and the thigh flexed to a right angle. of the other hand is placed in front of the anterior spine and the eath the trochanter. On pushing and pulling the femur with one reater trochanter is felt with the other to slide up and down on the pelvis. Sometimes in examining these congenitally luxated hips in r a distinct grating or cracking can be felt.

While one is usually able to diagnose the condition by the physical examination, it is nevertheless desirable whenever possible to have a skiagraph made. This will enable one to judge with exactness the height of the head in relation to the acetabulum and to a less extent the amount of anteversion of the neck, and may give considerable information concerning the formation of both the head and upper end of the femur as well as the acetabulum. It will not, however, enable one to detect a posterior displacement. Fortunately, this latter is almost always associated with a certain degree of upward displacement which can be recognized, and a posterior displacement can usually be detected by a careful physical examination.

Treatment.—In 1826 Dupuytren stated that cure of congenital luxation of the hip was impossible, but advised a pelvic girdle as a palliative measure. Later Landerer used a corset to counteract the lordosis and Langgaard devised a brace which was fastened about the pelvis, passed down the thigh and possessed a pad which made screw pressure over the trochanter.

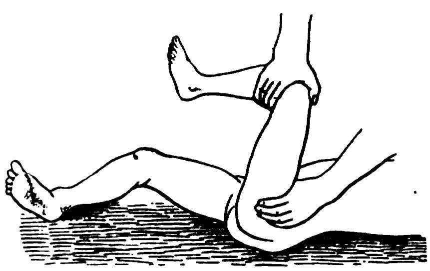


FIG. 1209.

Attempts at immediate reposition were made by Humbert, but were not successful, and the subject was brought into prominence by C. G. Pravaz, of Lyons, in 1847. Instead of the rapid traction of Humbert, he used strong continuous traction for four to eight months and then by means of extension, abduction, and strong pressure by a large roll under the trochanter replaced the head. Reluxations he treated by repeated replacements. His results were not sufficiently good and his methods were abandoned, only to be revived by Buckminster Brown of New York, who was followed by Bradford of Boston, Adams of London, and others. The extension treatment was brought to its greatest perfection by Max Schede and Mikulicz in 1894, both of whom obtained fairly good results.

The operative treatment began about 1840 with Guerin who tenotomized the muscles attached to the greater trochanter. He was followed by Brodhurst, Bouvier, Barwell, Pravaz, Jr., Coolidge, and others. Resection of the head by Rose in 1874 and Margary, of Italy, in 1882 proved after a full trial to be unsatisfactory.

The question of operative treatment was finally solved by Alfonzo Poggi, of Bologna, who in 1888 replaced the head of the femur in a newly made acetabulum by open incision. He was followed by Hoffa, who in 1890 and subsequently

ystematized the technic and caused the operation to be generally accepted. In 892 Lorenz advocated an incision along the posterior edge of the tensor fasciæ emoris muscle instead of the posterior incision of Langenbeck as used by Hoffa. Ioffa himself ater adopted a straight incision along the anterior edge of the reater trochanter. The cutting operation reached its acme in 1894 when it 'as advised by many in preference to all other measures.

At the International Congress in Rome in 1894, papers were read by Hoffa nd Lorenz advocating their cutting operations. Kirmisson and Mikulicz in-ined to traction treatment and Paci gave a résumé of the work which he had reviously published in the "Archivio di ortopedia" in 1890, 1891, 1892, and 893. He stated that he had practised his bloodless reposition method in wenty-eight cases, twenty-three of congenital luxation, three of pathological, nd two of old traumatic. He claimed good results from it in patients from ıree to twenty-one years of age. He presented the pelvis of a child of seven ears in whom Nota, of Turin, had replaced the hips four months previously. n one of these hips there was practically a perfect result. He also demonstrated is method on a patient before the assembled members.

The effect was magical. From this time forth the bloodless method was ıken up and the cutting operation reserved for exceptional cases. The follow-ıg year Lorenz, of Vienna, brought out his modification of Paci's method, and ɔme changes have been introduced by various surgeons since that date.

Method of Paci.—("Transactions of Eleventh International Medical 'ongress," Rome, 1894, p. 378.) Paci, as he himself said, used the ordinary ircumduction method which had been systematized in Italy by Fabbri. It 'as as follows: *First*, flex the thigh well on the abdomen, then push forcibly own on the knee so as to force the head downwards. *Second*, while retain-ıg the limb in the previous position slowly abduct the knee until it is 15 cm. 5 inches) away from the side of the body. *Third*, rotate externally until the xis of the leg (held at 90° to the thigh) is perpendicular to the long axis of the ody. *Fourth*, gradually extend the limb while being held in external rotation.

The extension was carried as far as was possible without the head reluxat-ıg. Sometimes the thigh was bent over the edge of the table and force was sed, to the extent in one case of breaking the femur. The limb was placed ı plaster and weight extension used for four months and then removed and he patient kept on crutches for six months longer.

Lorenz Technic.—(Joachimsthal, "Handbuch der Orthopädischen Chir-rgie," vol. ii, p. 169, etc.) The thigh is abducted until the adductor muscles re tense. These are then ruptured by direct pressure made with the ulnar order of the hand by cutting or sawing movements. In difficult cases abduct-ıg and rotary movements are made to mobilize the joint. Also traction may e made, either manual by the surgeon or instrumental or by two assistants ulling on a skein of yarn looped around the malleoli or the condyles of the emur. Counter-traction is made by fastening a sheet to the table while the erineum is protected by a pad of spongy rubber.

Reduction (Fig. 1210) is to be accomplished by having an assistant fix the

65

pelvis by pressure on the opposite side; the operator then grasps the hip with one hand, the thumb being posteriorly on the trochanter, and the flexed knee with the other, the thigh being vertical. The trochanter is then pushed upwards and forwards with one hand, while the thigh is lifted (traction) and abducted with the other until it is at right angles to the long axis of the body

FIG. 1210.

in the frontal plane or even a little more. If these manœuvres do not suffice, a wedge-shaped block (its edge covered with padding) is placed beneath the trochanter and the abduction is made over this (Fig. 1211).

Hoffa ("Joachimsthal," vol. ii, p. 176) abducted to 90° the flexed and strongly externally rotated thigh. It was moved to and from the body, up

FIG. 1211.

and down like a pump-handle ("Pumpenschwengel") until it reached the horizontal.

The Bartlett machine ("Journal of Medical Research," x, 440, 1904), much used in a modified form in Boston, resembles in principle that of Max Schede. By it traction is made with a winch and the femur forcibly abducted to 90°. The limb is then removed from the apparatus and the luxation re-

ɔy manipulation, or attempts may be made to push the head into ıile traction is still being made.

. Hibbs ("New York Medical Jour.," April 25, 1908) fastens the patient le by two straps passing over the crests of the ilia and down between ;hs, thus fixing the pelvis firmly. Then the leg is extended on the ⁄ith the thigh held in adduction and flexion on the abdomen, thus the head below the acetabulum. A metal wedge-shaped block is ought up through a hole in the table and adjusted, by a ball-and-oint, against the trochanter so as to direct the head upwards and for- The thigh is then extended and abducted, forcing the head to travel ., anteriorly, into the acetabulum. He has used the method in fourteen thirteen children from twenty months to eleven years of age. The ɔut up in varying degrees of flexion and abduction and he "doubts the ⁄ of any case wearing plaster more than two months, and at the most ıd in many a shorter time." In only one case was there reluxation g a replacement.

or's Pressure Method (G. G. Davis, "American Journal of Orthopedic " Jan., 1907):

FIG. 1212.

commonly used means of replacing a congenital luxation of the hip : Paci-Lorenz method. This is essentially a lever method, the fulcrum her the ilio-femoral (Y) ligament, a block, the hand as used by Lorenz, of the table as used by Paci, or a hard roll as used by Pravaz. The s accompanying this method have been numerous and are a constant To avoid them and yet to apply the requisite amount of force the ıbstitutes direct pressure for leverage. It is applied as follows: The ɔlaced on the table face downwards with the pelvis resting on a sand-bag leg hanging down over the edge of the table. If the table is well :he sand pillow may be dispensed with. The thigh is then well flexed ıght *close to the body* of the patient, the knee being flexed, and held her by the operator (Fig. 1212) or by an assistant (Fig. 1213). The then places the base of the palms of his hands on the trochanter l and makes downward pressure aided by the weight of his body. By ns the head is forced from its posterior to an anterior position and, in

easy cases, the reduction is practically complete, sometimes taking place with the usual jump or click. If the case is more difficult and more abduction is required, the patient may be brought more towards the middle of the table so that the knee and part of the thigh are supported by its edge and pressure again applied. Still more abduction can be obtained by placing a pad of towels beneath the knee so as to elevate it still more (Fig. 1214). By this means hyperabduction (beyond the frontal plane) can be obtained if desired. The head being low down the thigh may still be in a position of marked flexion. It is then flexed and extended by the pump-handle movement of Hoffa until it is at right angles to the long axis of the body when the plaster cast can be applied. The limb can be placed in either external or internal rotation. If the latter, then the cast extends below the knee. Traction and tearing or cutting of the muscles are not practised because unnecessary, although in an exceptionally difficult case tenotomy of the adductor longus might be of service. The method has been used in about fifteen cases. In one, age sixteen years, it

FIG. 1213.

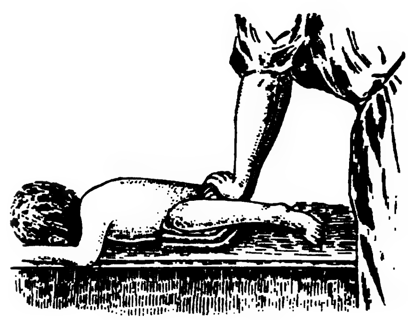


FIG. 1214.

failed. In another, aged twelve years lacking one month, it took four attempts to get a satisfactory amount of abduction. In the others, from two to ten and one-half years, satisfactory reduction was accomplished at a single séance.

Fixation: Applying the Plaster Bandage.—Reduction having been accomplished, the child is turned on its back and placed on a pelvic support (Fig. 1215) with the limbs in the desired position, either projecting out at right angles to the body or flexed or adducted to the extent desired. We put the limb up in extreme abduction for the first dressing and invert it and lessen the abduction at the second dressing. A strip of flannel bandage is laid on the leg next the skin, long enough to project considerably beyond the edges of the plaster. This is to be used for cleansing purposes, being pulled to and fro at intervals while the bandage is beng worn.

The limb and pelvis are covered either with a flannel bandage or stockinette and felt pads placed on the sides of the pelvis and inner surfaces of the knee to avoid pressure sores. The plaster bandage is then applied in the form of a spica embracing the thigh and pelvis. If internal rotation is desired, the plaster must include a part of the leg below the knee. In order to strengthen

the bandage and prevent reluxation a strip of strap-iron can be placed in the posterior part of the bandage running down from the pelvis to the thigh. Felt pads can be placed beneath this strip between it and the trochanter so as to force and maintain the head as far anterior as is desired (Fig. 1216). If both limbs are placed in internal rotation as suggested by Schede and advised by Mueller the patient sleeps on a suspended or supported Bradford frame (Fig. 1217) with the legs hanging down over its sides. If only one side is involved the patient can sleep on an ordinary bed with the leg hanging over its edge.

The first plaster dressing is left on from one to three or five months. If the tendency to reluxation is slight the dressings are changed at short intervals; if the tendency to reluxate is marked the dressings are kept on longer. In favorable cases in young children a single dressing will suffice. In others the limb will have to be brought down gradually at each change of bandage. From three months to nine months or even longer may elapse before all retaining bandages are discarded. Lorenz has laid considerable stress on subsequent massage and gymnastics, but if the reposition and stability of the joint are good they are not especially needed, especially if the muscles have not been unduly injured by a preliminary (I believe unnecessary) mobilization.

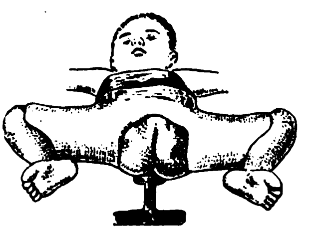


FIG. 1215.

If both hips are luxated, nearly all surgeons prefer to reduce them simultaneously instead of treating them one after the other. If the hips are operated on simultaneously the child is disabled on both sides and locomotion is practically impossible until the limbs are brought down at subsequent dressings. If, however, only one has been operated on, then, if the cast is satisfactory, the child can go around on crutches or a high shoe in two or three days. In cases near the age limit preliminary weight extension in bed for two to four weeks with the leg in an abducted position may be tried.

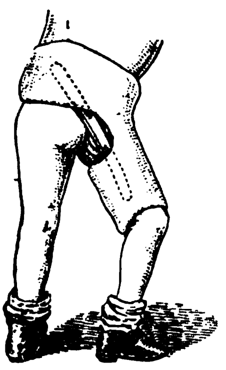


FIG. 1216.

In some instances, particularly in double luxations, difficulty may be experienced in bringing the limbs down parallel. When such is the case a strip of metal may be incorporated in the bandage running across from the inside of one thigh to that of the other just above the knees. This will tend to prevent abduction. If the plaster cast has been removed, Lorenz advises the use of an elastic band passing across from one knee to the other. To enable a patient with a one-sided luxation to go around, a high patten or shoe is used on the affected leg (Fig. 1218).

Double luxation cases can, as suggested by Lorenz, be given a small bench with rollers; by sitting astride it the child can push itself along (Fig. 1219).

As pointed out by Gourdon, Kirmisson, and others, when the limb is placed

in extreme abduction the head is not pointing correctly into the acetabulum, but is looking more forwards. Hence if this position is maintained too long the anterior part of the joint is weakened and an anterior transposition may result. For this reason it is best to change the position of the limb as soon as possible, without reluxation occurring, from the primary position of extreme abduction to one of moderate internal rotation, at the same time bringing

FIG. 1217.

the limb down a little or even to about 45°; the head then bores directly into the socket and is about perpendicular to the lateral pelvic plane. The greater the amount of anteversion of the head and neck that is present the greater is the amount of internal rotation necessary. In cases with extreme anteversion of the neck an osteotomy to correct it, as advised by Kirmisson, may be necessary, but that is very rare.

Results.—It is practically impossible to give an accurate statement of results. What one operator calls a good result another will call bad; what one calls an eccentric replacement, another will call a reluxation. Le Damany has called attention to the unreliability of the statements of the mother as to the great improvement effected.

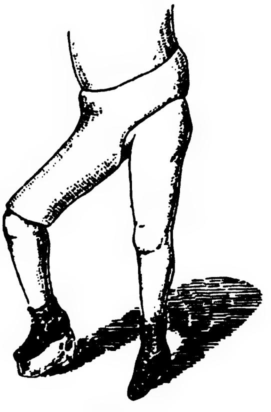


FIG. 1218.

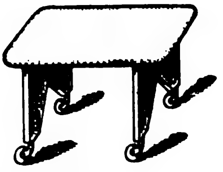


FIG. 1219.

Certain it is that with a judicious amount of suggestion on the part of the surgeon the parents at times may be persuaded to do and see almost anything. One fact, however, is evident and that is that the methods of replacement as well as of subsequent treatment as now generally employed have not changed materially since their general introduction.

Lorenz, at the Lisbon International Congress in 1906, stated that ideal

results were obtained in 50 per cent., and of the other 50 per cent. the greater part were transpositions below the anterior superior spine of the ilium.

Kirmisson at the same congress stated that in twenty-eight unilateral cases, two were found impossible of reduction and that good or even perfect results were obtained in eleven, or 39 per cent. Of twenty-four double cases only two had good permanent results. The results in double luxations are about one-half as good as in single luxations. Many operators claim more than 50 per cent. cures, especially in single luxations.

The fact remains that, according to Lorenz, and his statement is probably close to the truth, there are 50 per cent. more or less imperfect results.

He claims that in the transpositions or what he calls "lateral apposition," cases below and a little outside the anterior spine, while the limping is not improved the endurance is, and that they do not tend to luxate posteriorly.

We would like to agree with him in his view, but at present, at least, cannot. While the treatment undoubtedly does permanently benefit many of the cases, in others the condition seems to get worse rather than remain stationary until the cases can scarcely be distinguished from those who have had no treatment at all. In other words, we class transpositions under the head of failures, not total, it is true, but far from satisfactory. So distrustful of the results of the bloodless reposition is Sherman, of San Francisco, that he advocates replacement by open operation, not making a new acetabulum, but apposing cartilage to cartilage. His statistics are: In twenty-nine cases there were twelve functionally normal joints; eight anterior transpositions, one death and one ankylosis from infection. In twenty-seven cases followed by osteotomy he had 70.3 per cent. of normal function.

Personally, the difficulty experienced has not been in the reduction, but in maintaining the reduction. There seems to be little doubt that in some cases the acetabulum is so shallow as to absolutely fail to give proper fixation for the head of the femur.

When it becomes evident, after a thorough trial of fixation, that it is impossible to get a stable joint, then we believe that at present the best plan is to make an anterior incision and deepen the acetabulum.

Reduction by Open or Cutting Operation.—It is also to the Italians that the credit belongs of being the first to indicate the proper means to treat otherwise irreducible cases by operative means. Alfonzo Poggi, of Bologna ("Archivio di Ortopedia," 1888), on January 29, 1888, replaced the unresected head as nearly as possible in a newly scooped-out acetabulum by open incision. Many operations had been done before that time, but they were mainly on the muscles or resections of the head of the femur. Two years later Hoffa brought out his well-known method, and it is to him that the world is indebted for placing the operation on a firm basis and causing its worth to be generally recognized.

Hoffa at first used Langenbeck's incision which is a longitudinal one over the posterior portion of the joint. He also detached the muscles from the great trochanter. Later he made an incision beginning .5 cm. (1/5 inch) in front of

the upper end of the anterior edge of the greater trochanter and prolonged downwards for 6 cm. (2⅗ inches) in front of the trochanter. Lorenz modified Hoffa's operation by making his incision 6 to 7 cm. long downwards and backwards from just behind the anterior superior spine to the greater trochanter. It passed along the posterior border of the tensor fasciæ femoris muscle. He avoided the division of the muscles. The operation so performed has been called the Hoffa-Lorenz operation.

The writer operates as follows: An incision (Fig. 1220) three or four inches long is made directly downwards from the anterior superior spine. The fascia lata is split and the sartorius and iliacus muscles pulled inwards and the tensor fasciæ femoris and anterior edges of the gluteus medius and minimus pulled outwards. The separation of these muscles is made by blunt dissection in the line of the incision and exposes the capsule of the joint and the neck of the femur. The capsule is freely opened and the finger introduced downwards to determine the amount of contraction of the capsule and the condition of the acetabulum below. If any remnants of the ligamentum teres are present they are to be cut away. If there is sufficient contraction of the capsule to prevent the access of the head to the acetabulum, then a dilator is introduced and the fibrous structures stretched. For this purpose Pryor's uterine dilator, being very powerful, is well adapted (Fig. 1221). If the acetabulum is sufficiently empty and well formed, attempts at reduction can at once be made.

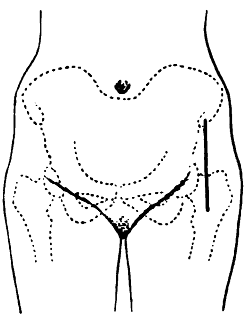


FIG. 1220.

If the acetabulum is either filled with fibro-fatty material or is too shallow to securely lodge the head of the femur, then it is to be cleansed out.

This may be done with a wood carver's gouge, which is sharply beveled on its outer surface (Fig. 1222), or, what is not so good, with a sharp Volkmann curette. To further smooth the cavity and even undercut, if necessary, the writer's rose burr (see Fig. 1223) will be found of service. It has cutting blades on only half of its circumference in order to avoid wounding the head of the femur. Attempts at reduction may now be made by the usual procedures of Paci or Lorenz. If these fail, then the writer's lever, shown in Fig. 1224 may be tried. The small or large blade, which can be reversed for use on the opposite sides, is used according to the size and age of the patient. One end is hooked under the edge of the acetabulum while the other passes over the head of the femur (Fig. 1225). By depressing the lever and abducting the femur the head can be made to enter the acetabulum. Should more space

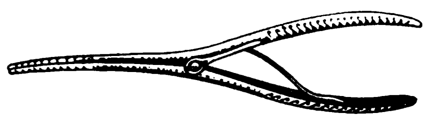


FIG. 1221.

be necessary for the manipulations, the tissues may be detached from the crest of the ilium back from the anterior superior spine as recommended by Codivilla. On the completion of the reduction these are again to be sewn in place with chromic catgut and the capsule and deep parts of the wound also

FIG. 1222.

closed as much as possible. A rubber drain is to be inserted, but is to be removed in twenty-four hours.

In operating the greatest care is to be taken not to injure the cartilaginous covering of the head of the femur. Removal of the cartilage and exposure

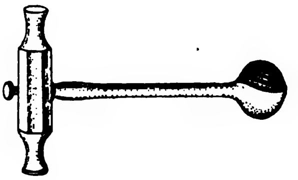


FIG. 1223.

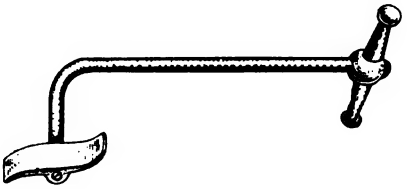


FIG. 1224.

of the bare bone of both the head of the femur and acetabulum is liable to lead to anchylosis or restriction of motion. The limb is to be put up in plaster of Paris in a sufficiently abducted and extended position to prevent reluxation.

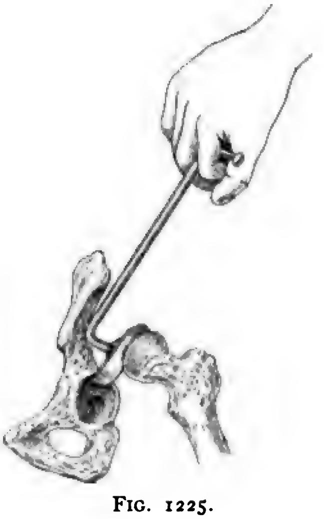


FIG. 1225.

The plaster may be removed every three or four weeks and passive motion made. It may be discarded in ten or twelve weeks. Should it be found to be absolutely impossible to replace the head in the acetabulum, then a new one

should be dug out of the side of the ilium and the head placed therein. This will give a stable support, but of course increases the shortening. Anchylosis is not likely to occur if the cartilage on the head of the femur is kept intact.

While the cutting operation is regarded unfavorably by many, the writer has found it to be very satisfactory. It must be admitted, however, that the operation is a difficult one and demands a skilled technic both from the standpoint of asepsis and reduction. It is the only thing that gives a fair promise of a stable and satisfactory result.

CHAPTER LXXXII

KNEE-JOINT

PUNCTURE. LAVAGE. INJECTIONS

Puncture of the knee is most commonly practised to withdraw serous effusions, recent blood extravasations, etc., and as a preliminary to lavage and the injection of various curative agents. The preparation of the patient, surgeon, assistants, and material must be as careful as if for an arthrectomy.

Step 1.—At the chosen point a little above and external to the patella inject a few drops of cocaine or analogous solution into the skin. With a tenotome puncture the skin. Through the puncture pass a trocar and cannula downwards and inwards in such a fashion that its point is made to touch the articular surface of the patella. This insures that the instrument has entered the joint.

Step 2.—Withdraw the stilette. Let the fluid escape. Clots of fibrin may plug the cannula; these may be removed by a probe. If nothing further is required, remove the instrument and apply a dressing which will exercise elastic pressure on the knee. If it is desired to practise lavage or injection, proceed to Step 3.

Step 3.—With an irrigator, or better, a common glass syringe connected with the cannula by sterile rubber tubing, fill the joint with salt solution or some mild antiseptic; disconnect the syringe from the cannula; permit the fluid to escape; repeat this washing as often as may seem necessary. If the disease is simple hydrops articuli many surgeons follow the lavage by injecting about three drams of 5 per cent. carbolized water. When tuberculosis is present one may inject the same quantity of a sterile emulsion of iodoform in glycerine (10 per cent. to 20 per cent.). J. B. Murphy uses the following emulsion: Iodoform, 10 per cent.; formalin, 2 per cent.; glycerine, q. s. In empyema of the knee Murphy, after puncture and lavage, injects a sufficiency of a 2 per cent. solution of formalin in glycerine to produce a mild amount of tension in the joint. He also uses this injection as a preliminary to most arthrotomies, as he believes the simple arthritis produced by it acts as an immunizing agent against infection during the major operation. In cases of traumatic dry arthritis Rovsing omits all lavage, notes that no fluid escapes through the cannula (if any *turbid* fluid escapes injection of vaseline is contraindicated) and then injects about 10 or 12 c.c. of sterile vaseline (see p. 987).

Step 4.—Withdraw the cannula. If necessary, close the puncture with a stitch. Apply dressings and a splint or light starch bandage. Keep the patient in bed for a few days and then permit him to go about with crutches. The injection may be repeated in from two to six weeks. The treatment is not

suitable when osteal lesions are present. If there is no marked improvement after two or three weeks, abandon the method.

Sclerogenic Injections (Lannelongue).—Nature seems to cure tuberculous foci by imprisoning them in an impenetrable capsule of fibrous tissue. Lannelongue has sought to stimulate nature to produce this capsule. His method is as follows: Cleanse the parts to be operated on. Charge an aseptic hypodermic syringe with a 10 per cent. solution of chloride of zinc. Inject 8 to 10 minims of this solution at each of various points around the diseased area. These injections must be made into healthy tissue, but immediately adjoining the disease. The irritating chloride of zinc is supposed to lead to the formation of scar tissue. Excellent results have been claimed, but the method has not become very popular.

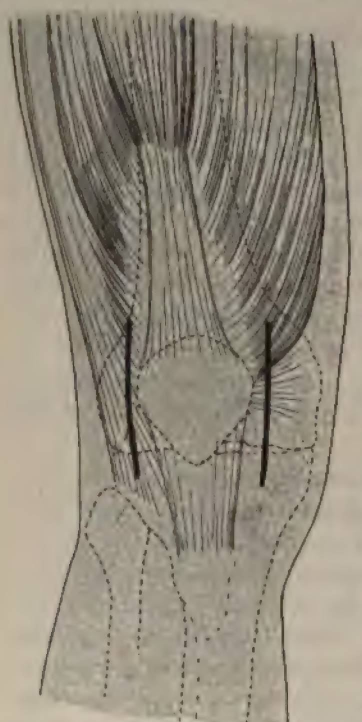


FIG. 1226.—Arthrotomy. (*Labey.*)

Arthrotomy Knee.—Arthrotomy may be performed for several purposes: (*a*) Exploratory; (*b*) for the removal of fluids, *e.g.*, serous effusion, blood, pus; (*c*) as a preventive measure after infected or suspected wounds; (*d*) as a substitute for puncture and injection; here the wound must be closed after the selected remedial fluid has been introduced; (*e*) for the removal of foreign bodies; (*f*) as a step in other operations on the knee.

Murphy, whenever possible, prepares the joint by injecting glycerine-formalin solution (p. 1035) a week or ten days before performing arthrotomy. Arthrotomy may be performed in several ways:

(A) **Antero-lateral Incision.**—For exploratory purposes or if serous or bloody fluid is alone present, make an incision one finger's breadth external to the patella from the level of the lower edge of the patella to a point about two fingers' breadth above the upper end of the patella (Fig. 1226). This incision is slightly curved, the concavity being towards the patella. Divide the skin and fascia. When the synovialis is reached pick it up with forceps and cut between the forceps so as to open the joint. Enlarge the wound in the synovialis with scissors so as to gain access to the upper pouch of the joint. Of course under certain circumstances a smaller incision suffices and should be made; for exploration and for many other purposes the larger cut described is essential. If pus is present or if the single incision is insufficient, make an identical cut on the opposite side of the patella (Fig. 1227). If drainage is required the wounds may be left open and loosely filled with gauze, or a rubber

drainage-tube may be pulled through under the quadriceps tendon, from one to the other. It is much better to avoid permitting any drainage tube or foreign body to penetrate the synovialis. *In draining a joint the tube ought merely to reach to the synovialis.*

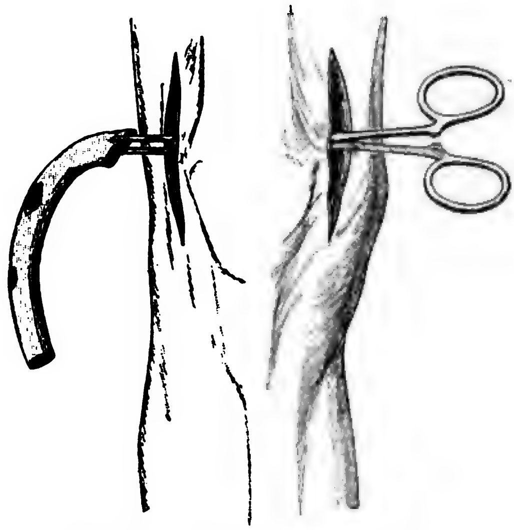


FIG. 1227.—Drainage knee. (*Labey.*)

(B) The above incisions may not provide sufficient drainage for the joint cavity near the popliteal space, hence it may be necessary to supplement them by *postero-lateral* incisions on one or both sides. These are, under the circumstances, mere counter-openings. A postero-lateral counter-opening is conveniently made as follows: Pass a closed forceps through the antero-lateral wound (Fig. 1228), through the joint and make it raise up the soft parts on the outer side just anterior to the hamstrings, thus avoiding the external popliteal nerve; on the inner side it may go between the tendons. With a knife make a longitudinal cut so as to expose the forceps, seize the end of a rubber tube in the forceps and with it pull the tube through the wound. Instead of pulling the tube through the joint, merely introduce it to the wound in the synovialis as its presence in the joint is liable to injure the synovialis disastrously. Postero-lateral incisions may and often are made as the primary incision, especially in cases of pyarthrosis, as they by themselves give good access not only to the joint, but also to those popliteal bursæ which most commonly communicate with the joint. The operation is as follows:

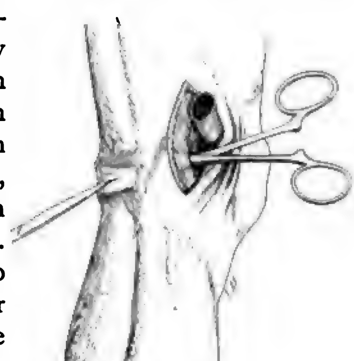


FIG. 1228.—Drainage knee. (*Labey.*)

(*a*) On the outer side.

Step 1.—Extend the knee. Palpate the tendon of the biceps. Make an incision about 2½ inches long, just in front of, and parallel to the tendon. This cut extends nearly down to the head of the fibula and divides the skin and fascia.

Step 2.—Slightly flex the knee so as to expose the anterior border of the biceps tendon. Retract the tendon backwards and expose the posterior border of the external condyle of the femur.

Step 3.—Open the capsule. Introduce the gloved finger into the joint and, guided by it, enlarge the opening as may be necessary.

(*b*) On the inner side.

Step 1.—The knee being extended, flex the thigh on the pelvis. This permits one to see and palpate a longitudinal groove beside and behind the internal condyle. The inner border of the groove is formed by the gracilis (coming from the pubis), the outer border by the semi-tendinosus coming from the ischium. Make a longitudinal incision in the above groove. The middle of the incision should be opposite the line of the knee-joint. Divide the skin and fascia. Expose the sartorius and half hidden by it, the gracilis. To the popliteal side of these tendons note the narrow tendon of the semi-tendinosus and more deeply situated the big semi-membranosus tendon. Retract these tendons forwards.

Step 2.—Open the joint on the posterior border of the internal condyle of the femur by an incision reaching from the border of the meniscus to the upper end of the capsule. If there is a serous bursa under the semi-membranosus, it is easily felt by the finger and opened. Instead of providing tubular drainage after postero-lateral incision, it has been advised to unite the posterior lip of the synovial wound to the skin by one or two catgut sutures. To obtain perfect drainage it is recommended that the knee be kept flexed at an angle of at least 20 degrees.

(C) **Arthrotomy by Transverse Incision.—Dislocation Method.**—This operation may be performed in several ways:

(1) **Transverse Section of the Patella.**—Make an incision from one condyle of the femur to the other across the middle of the patella. Divide the patella transversely with a saw. With knife or scissors divide the lateral ligaments, etc., so as to open the joint to the full extent of the cutaneous wound. Strongly flex the knee and divide the crucial ligaments. Pull the upper fragment of the patella and the soft structures around it strongly upwards so as to expose fully the upper synovial pouch, to do this lateral incisions may be necessary. Pull the lower fragment of patella downwards so as to expose the lower articular pouches. Keep the knee flexed to such an extent that the whole popliteal surface of the joint is exposed but no injurious compression is exerted on the popliteal vessels. After cleaning the joint cavity and swabbing with Harrington's solution or its equivalent fill it *loosely* with gauze and apply abundant dressings. Keep the limb flexed as noted above and watch the circulation of the foot carefully lest it be impeded by too great flexion of the knee.

Note.—Some surgeons do not cut the crucial ligaments, but this seems to be essential in bad cases.

(2) **Curved Incision.—Reflection of Patella Upwards** (Peck).—Make a horseshoe-shaped incision from the posterior border of one condyle to a corresponding point on the other condyle (Fig. 1229). The incision is convex

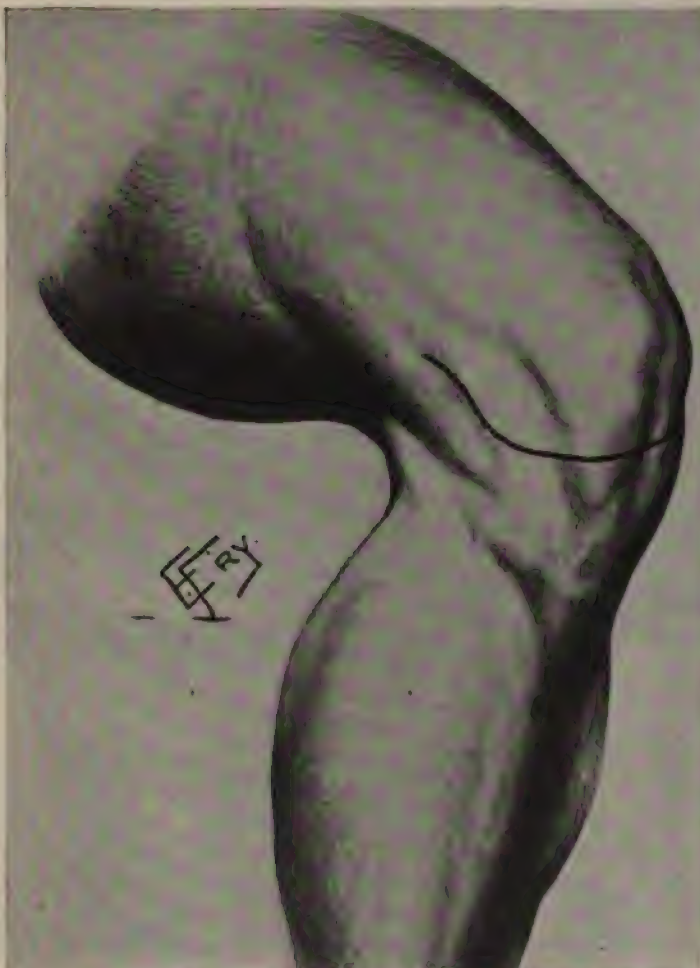


FIG. 1229.—Drainage knee.—(*Peck.*)

downwards and divides the tendo patellæ. Divide the anterior capsule, both lateral and both crucial ligaments, leaving the posterior ligaments alone intact. Make a lateral cut on each side upwards so as to permit the complete turning upwards of the anterior flap, including the patella and all tissue down to the joint (Fig. 1230). This exposes every nook and cranny of the upper synovial pouch. Keep the patellar flap in its new position by means of a stitch uniting

it to the skin of the thigh. The rest of the operation is the same as that already described. After recovery from the infective process has taken place, Peck and others recommend performing arthrectomy, arguing that even if it was possible to obtain closure of the wound without removing the articular surfaces, yet there would be no chance of getting a useful joint and there would be a

FIG. 1230.—Drainage knee.—(*Peck.*)

probability of fibrous anchylosis with subluxation of the tibia on the femur. To the author it seems wise not to adopt any hard and fast rule; if reduction and retention of the articular surfaces in proper position is easy then endeavor to obtain a more or less mobile joint, if this fail it is easy to resect at a later date.

Remarks on Arthrotomy.—When exploration of the knee is demanded the external antero-lateral incision is often the best; under special circumstances,

e.g., the presence of a palpable foreign body on the inner side, the incision may be made on the inner side or directly over the foreign body.

Jones' method of longitudinal median section of the patella is of very great value both for exploration and for excision of foreign bodies, etc. It is not proper in cases of infection.

Serous or bloody effusions are readily removed through the antero-lateral incision on one or both sides. In these conditions after evacuation of the joint and irrigation with salt solution the wound may be closed with or without drainage. When the fluid present is purulent much depends on the virulence of the infection and the evidences of sepsis. In cases of mild infection drainage may be established through antero-lateral incisions or such may be supplemented by postero-lateral counter-openings. When the infection is more severe, postero-lateral incisions are preferable, the wounds being left open or the posterior edge of the cut in the synovialis may be temporarily sutured to the skin. Through lateral incisions the author has, on a number of occasions, made extensive resection of necrosed synovialis and capsular tissues and has been astonished by obtaining a useful movable joint, although the large lateral wounds were left wide open after being loosely packed with gauze. When the infection is very virulent and absorption is great the preceding methods are insufficient. It is necessary to so expose the *whole* interior of the joint that loose gauze dressings may be applied to ever part of it in such a fashion that it will be easier for the septic products to be soaked up by the dressings than absorbed by the lymphatics. For this purpose the transverse incision is appropriate and has proved a very life-saving measure.

In suppurative cases it is wise, after evacuating the pus, to remove any masses of necrotic tissues. If these tissues are dissected away (scraping with a sharp spoon is often ineffective), one should remember that the dissection opens up fresh avenues of absorption, hence the wound should be swabbed with tincture of iodine, Harrington's solution or liquid carbolic acid. If the carbolic acid is applied, its effects should be neutralized by swabbing with alcohol. After treating the joint by the "dislocation method" with or without subsequent resection of the bone, anchylosis is most likely to result. This is of little moment as the operation is *not* one of convenience, but an urgent radical measure to save life and avoid amputation.

Gray has shown that many badly infected knees may be saved if the drainage tubes are permitted merely to reach but not penetrate the synovialis.

The difficulty of drainage of the knee-joint in the dorsal decubitis leads Flint to recommend the ventral posture.

Sixty per cent. of all penetrating wounds (traumatic) of the knee become infected (Flint). This being the case one ought to enlarge the wound as much as necessary so as to cleanse it and to remove all foreign bodies which may have been introduced. The cleansing of a punctured wound is notoriously difficult, hence in such cases it is probably wise to provide lateral drainage until the dangers of infective arthritis have passed. Operation for punctured wound of the knee, if done by a practitioner not thoroughly sure of his aseptic technic

and especially if carried out in unfavorable surroundings is not to be recommended, as the dangers from the operation would be greater than those from the original trauma.

Arthrotomy for the Removal of Loose Bodies.—Several varieties of organic bodies may lie loose in the joint and cause very distressing and crippling symptoms. The bodies may be single or multiple, may be absolutely free or be pedunculated. The bodies may occupy almost any part of the cavity, but only give rise to symptoms when nipped between the articular surfaces. They may be very movable and hence are liable to get out of reach. The patient by making certain movements can often bring the body into a superficial position.

FIG. 1231.

If the body is very mobile it is sometimes wise, after thorough cleansing of the parts, to harpoon and so fix it with a sterile needle. It is then easy to cut down on to the body under local anesthetic and remove it *without* introducing a finger into the wound.

Usually a general anesthetic will be required and a larger incision made in order to explore the cavity with a gloved finger. The operation is essentially that of antero-lateral arthrotomy. When a delicate pedicle is present it is easily ruptured; a stronger pedicle may require a snip of the scissors. The wound is closed by two layers of sutures without drainage.

Loose bodies can often be demonstrated by the X-rays, but a warning is here necessary. In the gastrocnemei muscles there are often present small

sesamoid bones (Fig. 1231), which may be mistaken for loose bodies in the joint.

Displaced Semilunar Cartilage.—Internal Derangement of the Knee-joint (Hey).—Many methods have been devised for exposing a displaced seimilunar cartilage. Annandale in 1885 described a method of anchoring the cartilage through a simple transverse incision.

Freeman reflects a **U**-shaped flap of all the tissues, including the capsule, upon the internal or external surface of the joint, as required, and lying between the lateral ligament, on one hand, and the patella and its ligament on the other (Fig. 1232).

FIG. 1232.—(*Freeman.*)

The base of the flap may either be upwards or downwards but it must be so placed as to freely expose the upper edge of the tibia and the semilunar cartilage.

It is now easy, in suitable cases, to reduce the cartilage and fix its edge to the periosteum by a few stitches. This treatment is now practically discarded in favor of excision which gives as good results and more insurance against recurrence. When the cartilage is exposed seize it with a strong hemostatic forceps or pull it outwards with a blunt hook. Cut it from its moorings with scissors or twist it until it tears free. Close the wound in the capsule and fascia with fine catgut. Close the skin wound. Dress. Apply a posterior splint or a starch bandage. Begin gentle motion in about two weeks. Gradually increase motion. Massage is useful. A number of weeks may pass before absolutely free and comfortable motion is possible.

Jones' Operation.—Robert Jones ("Annals Surgery," Dec., 1909) describes his method of operating as follows: "For some time I have given over operating with the knee in such a position that it has to be further flexed during the proceedings. Unless the greatest care is taken, the clothes get shifted or air is introduced into the joint. All surgeons of experience will have noted this. Tc avoid this risk I begin the operation with the patient's knee hanging at right angles over the foot of the table (Figs. 1233, 1234). To shift during the operation is to change the plane of the incision. The final cleaning of the knee take place while the joint is flexed and the skin tense. Some thicknesses of steril gauze squeezed out of 1 to 1000 biniodide of mercury is wrapped round th joint and the incision is made through the gauze, the cut edges of which ar fixed to the wound. The length of incision which practically always suffice

FIG. 1233.—Incision of knee. (*R. Jones.*)

is three inches, the incision into the capsule is much smaller (Fig. 1234). Lor skin incisions obviously add to the risks, and are only very exceptionally neede The incision should be slightly curved and extend from an inch within the low angle of the patella to half an inch below the tibial margin, curving more acutel at this point towards the lateral ligament. The interior of the joint is the inspected with the aid of carefully applied retractors. No less authorities tha Sir William Bennett and Mr. Whitelocke advocate entering the finger fo exploratory purposes. The finger should never enter the joint. Neither th surgeon nor the assistant should touch the wound with anything but steril instruments. The sutures for the capsule should be handed on forceps and I usually make the stitches a blanket-stitch. In the flexed position, the view is obtained of the interior of the joint and the cartilage can be

If the capsule plicates and hides the view, draw it outwards with a skeleton retractor which may be used to obtain a good view in any direction. The cartilage may be found in any position. It may be detached at its anterior extremity. It may be circumferentially split; it may be completely fractured; it may be completely twisted; it may be firmly fixed but with frayed inner border; it may be nodular; the posterior part may be in front; it may be attached at its extremities and free along the whole or part of its outer border; the anterior part may be ground away, or found quite loose as a separate body, or only the slightest movement may be possible, due to loosening of its moorings. The examination, which should be gentle, is facilitated by a sharp or blunt hook. It is only necessary to remove the loose portion of the cartilage, be it a frayed border, a circumferential tear or a detached anterior portion. Here I would offer a practical suggestion. Never pull upon the cartilage nor cut when pulling; this detaches more, and to my knowledge is a cause of recurrence.

FIG. 1234.—Incision of knee. (*R. Jones.*)

"Note the degree of detachment and go a short distance further with a knife cutting the cartilage clean across, and then complete the incision along the outer border. Having removed the cartilage, look for fringes, tabs or other possible agencies which may cause trouble in the future, and remove them. Stitching the cartilage should be an obsolete operation. If the cartilage is only slightly mobile and the history characteristic, it should be removed forthwith. During the operation, dabs taken directly from the sterile drum should cover the wound during any interval, and no dab should be used which has been exposed to the air.

"I never tie vessels, always use a tourniquet until the dressings are bandaged, and never drain. I used to drain, years ago, but I consider it quite unnecessary, and an additional communication between skin and joint. The synovial membrane capsule and skin should be separately sutured and the sutures should not pass through the whole thickness of the skin. I now know no anxious moments, the skin never reddens, nor do I have trouble with effusion.

"The stitches are left in position for eight days, the knee kept slightly bent

in a splint for the same period, or a few days longer, and then passive movements and massage are started. Special attention should be paid to the weak qaudriceps and in from three to four weeks normal exercise should be allowed."

Robert Jones' median longitudinal section of the patella gives remarkably good access to the knee for the removal of any misplaced cartilages as well as for operation upon the tibial spines for which it was devised.

In operating on a displaced semilunar cartilage safety demands either the use of rubber gloves or strict adhesion to König's rule never to put a finger in the wound.

When ought we to operate for displaced semilunar cartilage?

We ought *never* to operate before giving conservative means a fair and protracted trial. Hence acute cases are not for operation. Cases without effusion can generally be kept comfortable or cured by the use of some hinged apparatus to the knee or even by raising the inner side of the heel of the shoe so as to make the patient walk in a pigeon-toed fashion. When effusion is present (not acute synovitis) or when there is crackling on motion, operate. The effusion means constant irritation and injury to the synovialis, the crackling generally means that the cartilage has become rolled upwards and jointward more or less like a pea.

In the "British Med. Journ.," Dec. 9, 1905, Mr. A. E. Barker describes some atypical forms of internal derangements of the knee. The symptoms and history in these cases are identical with the classical lesion. The pain and tenderness are on the inner and anterior aspect of the head of the tibia. After opening the joint by a curved internal antero-lateral incision Barker found the meniscus normal, but when the knee was flexed and the tibia rotated outwards a long white "tag" of dense fibrous tissue was seen projecting backwards from the loose tissue behind the patella. On the removal of the tag, cure resulted.

Under similar circumstances after the same incision Barker found no displacement of the internal cartilage, no retropatellar "tags," but beyond the crucial ligament he saw a white mass which he pullled forwards with a hook and found it to be the *external* cartilage attached at both ends but torn from the coronary ligament by an injury sustained forty-four years before. Remember that flexion and external rotation of the knee after it is opened may reveal the cause of disabling symptoms and permit of cure. Remember that the synovialis of a healthy joint only feebly resists infection and hence that the ungloved finger must never touch a wound made in a joint.

J. B. Murphy always endeavors to render the knee immune to infection by a preliminary injection of formalin-glycerine (2 per cent.).

Repair of Ruptured Crucial Ligaments.—Mayo Robson operated on a man for lameness resulting from a severe accident sustained nine months previously ("Clinical Society," London, Nov. 28, 1902). Battle operated on a case in similar fashion. "On admission, the right knee was swollen but free from tenderness. When the muscles were pressed the bones were in good position, but as soon as the muscles were relaxed the tibia fell backwards until stopped by the ligamentum patellæ, and on manipulation the head of the tibia

ould be brought forwards in front of the femur, there being also free lateral novement of the head of the tibia on the femur and some fluid in the joint. Not only were all the ligaments relaxed, but the crucial ligaments had been uptured. On November 21, 1895, the joint was opened by a semilunar ncision carried across the front and dividing the ligamentum patellæ. The ynovial membrane was found inflamed, and there was excess of fluid in the oint. Both crucial ligaments were completely ruptured, having been torn rom their upper attachments, the ends being in a shreddy condition. They vere stitched in position by means of catgut ligatures and the anterior being titched to the synovial membrane and tissues on the inner side of the external ondyle, and the posterior, which was too short and was split in order to lengthen t, was fixed by sutures to the synovial membrane and cartilage on the outer ide of the inner condyle. The wound was then stitched up by means of buried atgut sutures, and was closed superficially by interrupted silkworm-gut utures. Complete restoration of the normal movements of the joint occurred. The stitches were removed on December 4, and on the fourteenth plaster of Paris was applied, and he was allowed to get about on a Thomas' splint and to go home. The plaster was removed in a month, after which movement gradually returned under massage. When seen on October 24, 1901, the patient was walking without a limp and could run. He said that his leg was perfectly strong, and that he could work eight hours a day at his old employment of geting coal, and that he had never been off a day on account of his knee since the year of his accident. The joint could be extended to the straight line and lexed just beyond the right angle, there being no abnormal lateral or anteroposterior mobility whatever."

Pringle has had two cases of injury to the knee in which abduction while the knee was extended was a prominent symptom. In both cases the provisional diagnosis was ruptured internal lateral ligament. On opening the knee of one of these cases the anterior crucial ligament, still attached to its bony insertion, was found to be torn off the tibia, taking the tibial spine with it. Pringle sutured the spine in place and obtained a good result. In the second case, after opening the knee, the anterior crucial ligament was found torn from its femoral attachment and was then sutured by Pringle to the tissues on the median side of the external condyle ("Annals of Surgery," Aug., 1907).

W. J. Frick repaired the ruptured anterior crucial ligament in two cases, one of his patients was a professional base-ball player who was able to resume his work within six months of the operation.

Robert Jones' Operation (R. Jones and S. Alwyn Smith, Brit. Journ., Surg., i, 89) is designed for treatment of fractures of the tibial spine "when full extension is not possible and disability exists in addition, whether it be pain stiffness or effusion." Flex the knee over the table at almost a right angle. Make a vertical median incision from one inch above the patella down to the tubercle of the tibia. Saw the patella longitudinally and split its tendon. Separate the segments of the patella to the border of the condyles. Remove the fat from behind the patella and so gain a good view of the spine and of the anterior crucial

ligament. Remove any obstructive mass. Straighten the knee. Suture the ligamentum patellæ, the aponeurosis and the quadriceps tendon. Do not wire the bone.

E. M. Corner (Trans. Surg. Sect. A. M. A., 1914) is an enthusiastic advocate of the Robert Jones method of opening the knee. To gain free access he splits the quadriceps upwards as far as may be necessary. He lays great stress on the importance of careful suture of the synovialis with fine catgut to prevent blood entering the knee as hemarthros is very favorable to infection. After operation no splint is necessary though its use for twenty-four hours may be of value. The patient remains in bed for three weeks. Active motion does not need to be preceded by passive motion.

Through the Jones' incision Corner operates on displaced semilunar cartilages; ruptured or stretched crucial ligaments; fractures of the tibial spines; various fractures of the femur, etc. He urges that the synovialis covering the fat below the patella be left intact if possible or, if divided, that it be carefully sutured.

Operation for Stretched or Loose Crucial Ligaments (Corner).—The anterior ligament is almost invariably affected. Bore a hole through the external

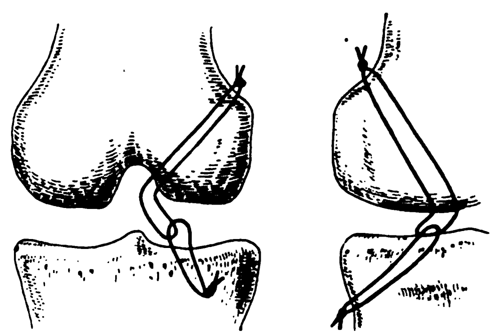


FIG. 1235.

condyle and through the loose ligament. Thread a *non*-absorbable suture on the drill and pull one end of it through the condyle. Pass the other end of the suture around the ligament and pull it through a second hole bored in the external condyle. When the suture is tightened and tied the relaxed ligament is tightened and reefed.

If the posterior crucial ligament is at fault the suture would be passed through the internal condyle. The knee ought to be a little flexed when the suture is tied.

Operation for Fracture of Tibial Spine.—In spite of the advice of Robert Jones, Corner advocates fixing the fragment of spine by a catgut suture passed twice through the tibia in the same way as is done through the femur in reefing the crucial ligament.

Operation for Ruptured Crucial Ligament.—When the ligament is so injured that its repair is impossible and when it is causing much disability Corner passes

a **U** suture of wire through two perforations in the external condyle and loops it through a similar wire suture which perforates the tibia (Fig. 1235). The value of this operation is very doubtful.

Operation for "Internal Derangement of the Knee."—Robert Jones' median incision is recommended by Corner in the treatment of displaced semilunar cartilages and for loose cartilages even when they seem single and easily excised through a small incision directly over them, the reason for this being that other

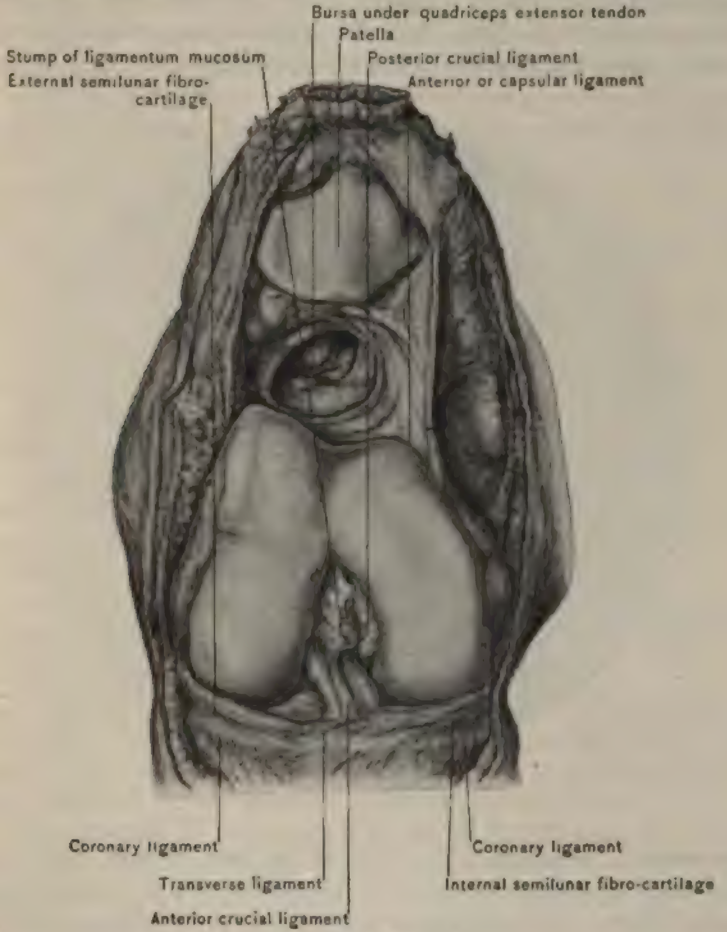


FIG. 1236.—(*Deaver.*)

remediable lesions are so often present which would be overlooked and cause subsequent chagrin if the smaller incision had been selected.

Figure 1236 will remind the reader of the anatomy of the knee.

Figure 1237 shows fracture of the tibial spine in which the chief symptoms were tenderness, swelling and undue lateral mobility. Hayden treated the case by immobilizing with plaster of Paris and obtained a perfect result about 79 days after the injury was received.

Chir.," 1912, No. 28), before applying the saw, 'al straight position and then saws *partially* ı. With the limb in this position it is much rrect lines. After partial division of the bones, one section. With forceps or saw remove the surface of the femur. Unless this is done the h and between the remnants of the epicondyles ıterfere with healing (Riedel). Still keeping the end of the tibia upwards so as to be clear of the popliteal space. Saw a thin slice from the tibia, articular surface. With forceps trim the sharp oving the lower end of the ful to locate and avoid the s line into view it may be n slice from the side of the mine the raw surfaces of remove it with the sharp whole wound territory and se. Clean, preferably by . Close the wound with a fracture. Voluminous ly a long posterior splint. the limb elevated to an position is retained for at

rectomy and excision may er from the above mostly int cavity is exposed. ibed very fully merely as ecause of superiority over be considered.

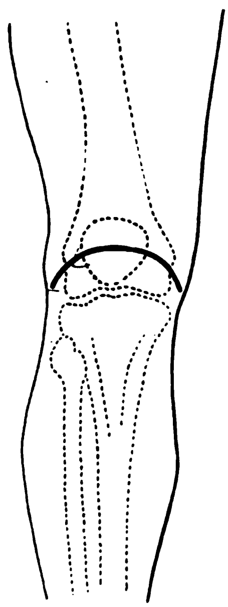


FIG. 1241.—Volkmann's incision.

Transverse Incision.— other make an incision of the patella (Fig. 1241). The cut is made to course, and opens the joint. Saw through the ıarp retractors pull the lower fragment of the rds, thus exposing the synovialis lining the an- of the joint. With forceps, scissors, and knife portion of synovialis from its connections until reached. Remove the semilunar cartilages and he lateral and crucial ligaments. Flex the knee in contact with the thigh and pull the leg down- e joint is made to gape widely and the posterior hat opposite the popliteal space, is made freely

Repair of Ruptured Lateral Ligaments.—When the lateral ligaments of the knee are ruptured they may be exposed and sutured but earlier use and better motion and strength may be expected from the following procedure reported by E. Lexer ("Archiv f. klin. Chir.," xcviii, 819). Expose the injured parts by a free incision. Suture any wound of the joint capsule. From the tendon of the rectus femoris obtain a non-pedunculated (unattached) flap of suitable length and thickness. Suture the flap to the femur above and the tibia below. If mere suturing of the flap to the periosteum seems insecure, reflect a flap of periosteum, cut a groove in the bone, place the end of the flap into the groove, fix it there with a staple and cover with the periosteal flap.

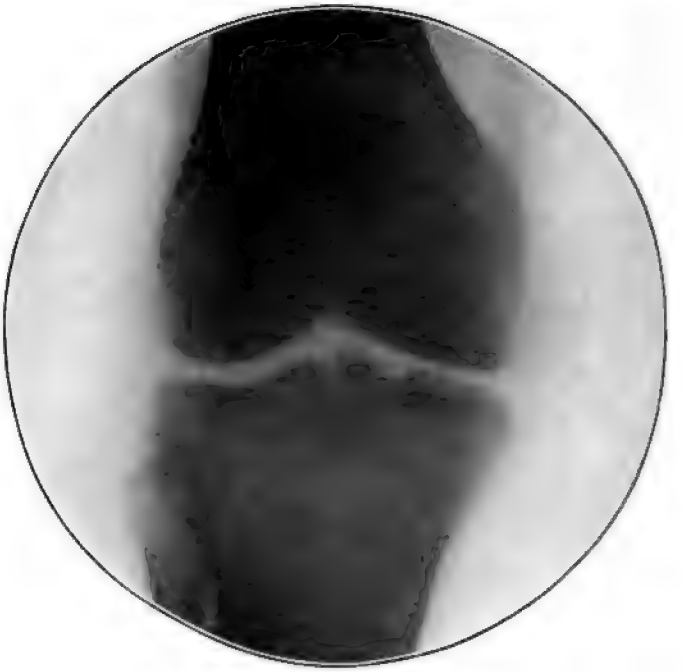


FIG. 1237.—(*Hayden.*)

Arthrectomy.—Excision.—The term arthrectomy is here used as meaning the removal of synovialis either alone or plus excision of the diseased portions of cartilage and bone. The term excision is reserved for operations where the whole articular surfaces are formally excised.

Method A.—Lateral Incision.—*Step* 1.—Beginning at the inner side of the ligamentum patellæ, make a curved incision upwards and backwards to the anterior margin of the internal lateral ligament where it crosses the line of the articulation; continue the cut upwards over the internal epicondyle and make it curve forwards and upwards around the inner and upper part of the superior synovial pouch (Fig. 1238). Beginning at the outer side of the insertion of the ligamentum patellæ, make a corresponding incision on the outer side of the

int. Both these incisions penetrate at once to the bone in the lower part of e incision, while in the upper part the vasti are divided and articular capsule exposed.

Step 2.—**Synovialectomy.**—With sharp retractors elevate the anterior edge the wound (on the outer side) from the capsule. With forceps, knife, and issors dissect the anterior part of the diseased capsule from the soft parts cov-ing it, until the patella or the middle line (Fig. 1239) is reached. Separate the ›per synovial pouch from all its surroundings. Divide the synovialis where it inserted into the patella. Make a similar dissection through the internal ound and remove the separated synovialis. Dislocate the patella outwards in ch a manner as to expose its under surface and that of the quadriceps and the itellar tendons. Inspect these structures and remove from them any shreds synovialis which may have been left. If it is :cessary to remove the synovialis from the pop-eal side of the joint, make a *partial* division of e internal lateral ligament and, if necessary, of e tendo patellæ. Dislocate the joint so as to ake the articular surface of the femur (or tibia) otrude through the inner wound. To obtain mplete exposure it is necessary to divide the ucial ligaments. With great care dissect away e synovialis from the popliteal surface.

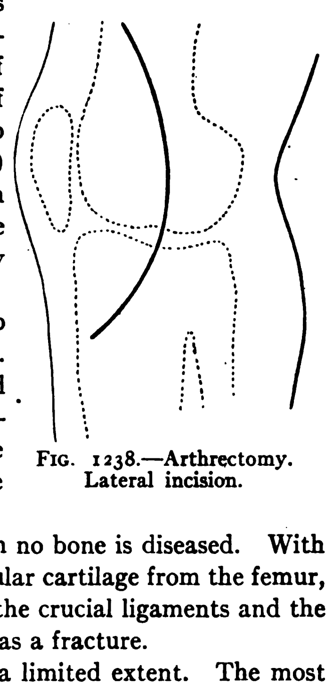


FIG. 1238.—Arthrectomy. Lateral incision.

This completes the synovialectomy. If no ore disease requires removal, cleanse the wound. ι tuberculous cases it is wise to rub the wound th iodoform powder. If possible unite the cru-il ligaments with catgut sutures. Repair the teral ligament and patellar tendon. Close the ound with or without drainage.

Step 3.—(*a*) Bony anchylosis is desired though no bone is diseased. With strong knife or with a chisel pare away the articular cartilage from the femur, ›ia, and patella, removing also the remnants of the crucial ligaments and the milunar cartilages. Close the wound and treat as a fracture.

(*b*) Foci of disease are found in the bones to a limited extent. The most mmon lesions are foci of tuberculous granulation-tissue infiltrating and ›sorbing the bone, and necrotic foci. If the active advance of the disease has ased, the diseased foci will be found surrounded by a mass of sclerosed bone— favorable sign. With a sharp spoon or a gouge remove all the diseased tissue. ecrotic foci are often so intimately attached to the surrounding bone that they quire removal by means of chisel and mallet. After removal of the disease ab the osseous wound with tincture of iodine or rub in iodoform powder or fill e cavity with Mosetig's bone plug. Close the wound with or without drainage ıd treat as a fracture.

Step 4.—**Excision or Resection of the Joint.**—Synovialectomy or excision local osseous foci of disease is inadequate: it is necessary to remove the

articular ends of the bone. Flex the hip. Make the lower end of the femur protrude through the wound (Fig. 1240). Apply a saw at right angles to the

FIG. 1239.—Arthrectomy through lateral incision.

FIG. 1240.—Arthrectomy through lateral incision

femur and saw off the articular end of the bone. Be careful as to the line of section, so that when the sawn surfaces of the femur and tibia are approximated the patient may have a straight or very slightly flexed knee without

um. Riedel ("Zent. für Chir.," 1912, No. 28), before applying the saw, the knee into the natural straight position and then saws ***partially*** both the tibia and fibula. With the limb in this position it is much divide the bones in the correct lines. After partial division of the bones, knee and complete the bone section. With forceps or saw remove the sharp edge of the raw surface of the femur. Unless this is done the ge of bone may do harm and between the remnants of the epicondyles pace is left which may interfere with healing (Riedel). Still keeping the xed, push the articular end of the tibia upwards so as to be clear of the s, especially those of the popliteal space. Saw a thin slice from the tibia, the saw parallel to the articular surface. With forceps trim the sharp the bone. When removing the lower end of the young people, be careful to locate and avoid the al line. To bring this line into view it may be y to shave away a thin slice from the side of the outer condyle. Examine the raw surfaces of . If disease is found remove it with the sharp chisel. Review the whole wound territory and any remnants of disease. Clean, preferably by n, all fistulous tracts. Close the wound with out drainage. Treat a fracture. Voluminous s are necessary. Apply a long posterior splint. patient in bed with the limb elevated to an ertical position. This position is retained for at nty-four hours.

other methods of arthrectomy and excision may d shortly as they differ from the above mostly anner in which the joint cavity is exposed.

od A has been described very fully merely as of convenience not because of superiority over procedures about to be considered.

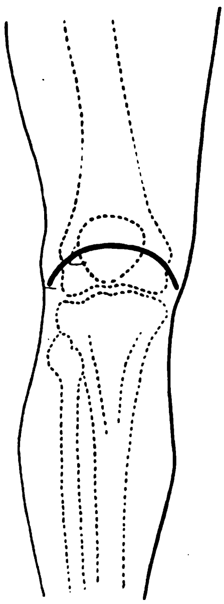


FIG. 1241.—Volkmann's incision.

od B.—Volkmann's Transverse Incision.— e epicondyle to the other make an incision sses over the middle of the patella (Fig. 1241). The cut is made to throughout its whole course, and opens the joint. Saw through the ransversely. With sharp retractors pull the lower fragment of the orwards and downwards, thus exposing the synovialis lining the anall of the lower pouch of the joint. With forceps, scissors, and knife he above-mentioned portion of synovialis from its connections until lunar cartilages are reached. Remove the semilunar cartilages and s together. Divide the lateral and crucial ligaments. Flex the knee back of the calf lies in contact with the thigh and pull the leg down-By this manœuvre the joint is made to gape widely and the posterior of the capsule, viz., that opposite the popliteal space, is made freely

accessible (Fig. 1242). Dissect away the posterior synovialis. Remember location of the popliteal vessels and nerves.

With sharp retractors pull the upper fragment of the patella forwards : upwards and dissect away the synovialis of the upper pouch in the same man as was done with the lower. The deep fascia of the thigh may prevent necessary elevation of the flap containing the patella; if this is so make a lo tudinal incision through the fascia on each side of the patella, without cut the skin.

FIG. 1242.—Arthrectomy.

Excise the articular ends of the bones as already described. When clo the wound it is necessary to unite the divided patella by means of sutures, p erably of catgut (chromicized or iodized).

Method C.—Make a **U**-shaped incision from one epicondyle to the otl the convexity of the incision corresponding to the insertion of the ligament patellæ. The incision only involves the skin and subcutaneous tissues. Refl the **U**-shaped skin flap upwards. This exposes the patella and part of the c sule of the joint. Make a transverse incision through the fascia covering t patella. Bisect the patella transversely with a saw. Divide the articu capsule on each side of the patella. Proceed as in Method B.

Method D.—This method is the same as C except that the convexity of t skin flap is upwards.

Method E.—Beginning at the posterior part of one femoral condyle make :urved incision which ends at a corresponding point on the other side of the ee. The lowest point reached by the curved incision is in the middle line the insertion of the ligamentum patellæ. The cut reaches to the bone 'oughout its whole length. The flap thus outlined contains the patella and ıst be reflected upwards. The rest of the operation is to be carried out on the es laid down in describing Method B.

Method F.—This method is the same as Method E, except that the concity of the curve is directed upwards and the quadriceps tendon is divided tead of the ligamentum patellæ.

Method G.—Same as Method B, but the addition of two lateral incisions kes the wound **H**-shaped. Riedel advises suturing the transverse wound l leaving the lateral ones to heal by granulation.

Remarks on Arthrectomy and Excision.—Use of Tourniquet or Elastic ıstrictor.—A few surgeons prefer to omit the use of the elastic constrictor, : the vast majority find it not only harmless, but most useful.

König's plan is adopted by most surgeons; the constrictor not being loosened :il after the patient has been returned to bed and his leg fixed in a more or ; vertical position.

Drainage.—Most surgeons provide for drainage by means of tubes, rubber ›ue, cigarettes, or silkworm-gut. Rutherford Morison closes the wound with- : drainage even when hemostasis is only attended to by posture as noted above.

Approximation of the Sawn Ends of the Bones.—Many means have been d to maintain apposition of the bones: bone pegs, screws, removable pins, e, suture, etc., etc. All are unnecessary. If the bones are placed in apposiı and kept at rest by means of a splint nothing further is required.

Treatment of the Patella.—After arthrectomy the patella is always carey preserved; after excision of the joint it has frequently been removed. the author it appears that it ought to be preserved unless it is the site of too ch disease to permit of conservative treatment.

How much Bone Ought to be Removed when Excision is Practised?— The femur. Never injure the epiphyseal line in the young. Remove as le of the bone as possible, just enough to provide a good raw surface for on with the tibia. Remember that the line of section need not be above highest point of the disease (tuberculosis), the foci of disease may be reved with spoon and chisel. As a rule, less of the tibia is removed than of the ıur. From the patella only remove diseased tissue.

In performing arthrectomy in children many surgeons remove the articular l patellar cartilage with a knife till raw bony surfaces are exposed. This es good bony anchylosis.

Indications for Operations in Tuberculosis of the Knee.—*The tendency uberculosis is towards cure.* This must be remembered by the ambitious ng operator. General supportive treatment, especially a generous supply ›roper food and a life in the open air in proper surroundings explain why ; easier to get good results in the rich than in the poor.

mobility under an anæsthetic. A creaking stiff joint with or under anesthesia should be excised" (Morison).

Any method of operating is good which fills the follow Free access to the joint. Ready removal of all diseased tissu mum destruction of healthy structures, and the reconstru useful limb with an anchylosed knee and as little shortening

Operation is far more rarely indicated in children than in belonging to the poorer classes operation may be required to pense, although the disease might well be considered curabl means.

Absolutely typical excisions are rarely proper. The true s cases, explores, removes the disease, and repairs the parts in calculated to give a useful limb.

At present anchylosis is almost always to be sought for Murphy and others on the interposition of fat, etc., between leads to the hope that even after excision of the knee for tu movable joint may be obtained.

Arthritis Deformans.—W. Müller ("Archiv für klin. C advocates operative interference in certain cases of arthrit reports good results. The operation consists in exposing th by lateral incisions, excising all the diseased synovialis, ext bodies and with a chisel shaving off all bony excrescences. skin wounds are separately closed with sutures, drainage pro dressings applied and rest maintained. Passive motion is beg third week. The after-treatment consists of massage an (sometimes under anesthesia) patiently carried out. Active

tomy is indicated for exploration, to be followed by some form of atyp- resection according to the lesions found.

'ongenital Dislocation of the Knee.—Hübscher's Operation.—Hübscher ι Salis, "Deutsche Zeitschrift für Chir.," cxiv, 148) operated on a case ıterior dislocation of the tibia on the femur in a girl fourteen months of age. patella was absent. Manual reduction was impossible. The skin was cted in a flap from in front of the knee (Fig. 1243). The tendo patellæ found to be short and to constitute an impediment to reduction. The lon was incised longitudinally down to its insertion into the tibia (Fig. 1244).

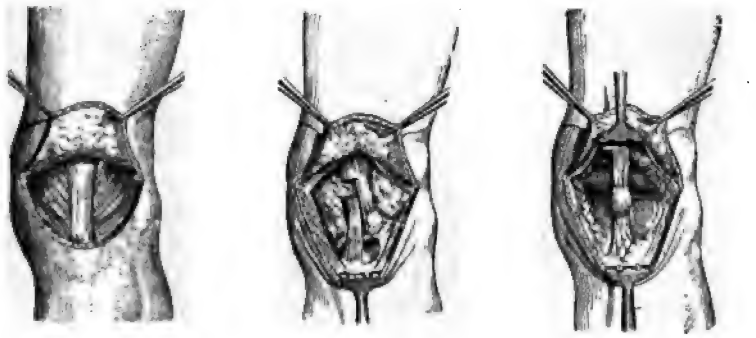


FIG. 1243. FIG. 1244. FIG. 1245.

FIGS. 1243, 1244 AND 1245.—Hübscher's operation. (*Hübscher.*)

ortion of the tibia corresponding to the insertion of one-half of the tendo ellæ was separated from the rest of the bone. The other half of the tendon divided transversely high up. Only after division of the anterior capsule he knee was complete reduction possible. The two halves of the patellar nent were united in such a manner that the fragment of tibia attached to of them lay in the normal position of a patella (Fig. 1245). The wound was ed. The knee was immobilized in a position of slight flexion. The result good.

CHAPTER LXXXVII

PATELLA. TUBERCULOSIS

In cases of primary tuberculosis of the patella when the focus of disease is small Murphy advises the removal of the diseased focus, the filling of the resulting cavity with Mosetig's iodoform plug or with his own glycero-gelatin-formalin plug. [Murphy's plug is made as follows: Boil 100 c.c. white gelatin in 150 c.c. glycerine and 500 c.c. water. Add 1 to 2 per cent. of formalin.]

FIG. 1246.—Excision of patella. (*Murphy.*)

In advanced cases which do not involve the whole patella preserve the cartilage between the patella and the joint for fear of infecting the joint. The cases suitable for the above treatment are rare and more rarely still, will a sufficiently accurate diagnosis be made, as the operation should be carried out without direct inspection of the joint cavity.

When the patella is irreparably diseased, but the knee-joint has escaped tuberculous involvement, excision of the patella is proper. In such cases the knee will have suffered from acute synovitis, due to the proximity of the tuberculous foci.

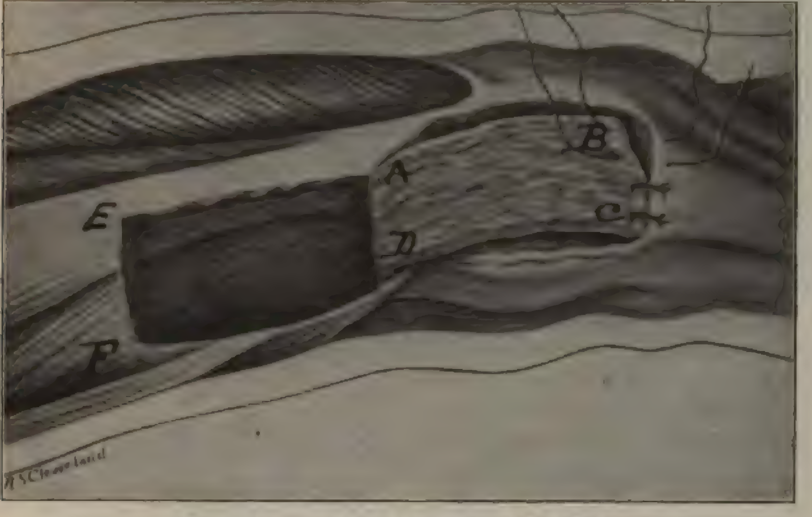


FIG. 1247.—Excision of patella. (*Murphy.*)

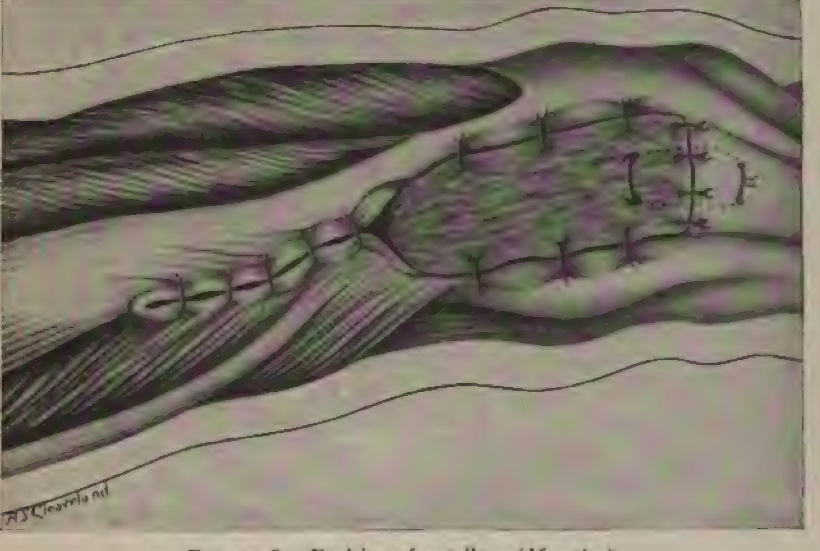


FIG. 1248.—Excision of patella. (*Murphy.*)

Murphy's Method of Excising the Patella.—Preliminary Treatment.— Before almost all operations on the knee-joint (fractures of patella, misplaced cartilages, etc.). Murphy produces a chemical or simple arthritis and only

operates after the patient has recovered from this. He believes that the *cured* arthritis produces a local immunity to infection and traumatic irritation. If this idea is correct, the Murphy has a habit of being correct, the preliminary treatment is important.

Twenty-four hours *prior* to use, prepare a 2 to 5 per cent. solution of formalin in glycerine. Inject 2 to 6 drams of the solution into the joint a week or ten days before operation.

The Operation.—*Step* 1.—Open the knee-joint by a 7-inch incision on the outer side of the patella (Fig. 1246), ("Surg., Gyn., Obst.," March, 1908, p. 266).

Step 2.—Make a subaponeurotic excision of the patella, leaving the cut ends of the quadriceps tendon and tendo patellæ exposed.

Step 3.—Reflect downwards a flap (A B C D) (Fig. 1247) consisting of portions of the quadriceps tendon and vastus externus muscle. The flap must be long enough to easily reach the cut end of the tendo patellæ. Stitch the end B C of the flap to the liagmentum patellæ either in the end-to-end or overlapping fashion. Close with sutures the defect A E F D.

Step 4.—Suture the aponeurosis of the patella securely to the divided edge of the flap (Fig. 1248).

Step 5.—Close the skin wound, after providing for drainage. Apply dressings and a straight posterior splint.

It was shown long ago by Wharton Hood that the patella is by no means essential to good function of the knee, hence the above operation does not produce so much disability as might be suspected.

CHAPTER LXXXIV

OSTEOTOMY FOR BONY ANCHYLOSIS OF THE KNEE

When tuberculosis is the cause of the bony anchylosis it is wise to operate as far as possible from the joint lest encapsulated infective agents be let loose. Operation is indicated when malposition interferes seriously with walking or standing. Whichever method of operating on the anchylosed bones is chosen, contracture of the ham-string muscles may interfere with correction. Under such circumstances tenotomy, tendon lengthening, or perhaps transplantation of the ham-strings into the quadriceps tendon becomes necessary.

Rhea Barton (1835) was the first to perform open, and Langenbeck (1852) to perform subcutaneous osteotomy for knee anchylosis. Gurdon Buck excised an anchylosed knee (essentially a cuneiform osteotomy) in 1844.

I. **Linear Osteotomy of the Femur.**—On either the inner or outer side of the rectus tendon "on a level with a line drawn transversely, a finger's breadth above the upper portion of the external condyle," make a longitudinal wound sufficient to admit a Macewen osteotome. Proceed exactly as in supra-condyloid osteotomy. Figures 1249 and 1250 show the result of this section.

II. **Linear Osteotomy of Both Femur and Tibia.**—This operation is suitable in cases where section of the femur alone is insufficient. Divide the femur as described in the preceding paragraphs. Divide the tibia immediately below the anterior tubercle (see p. 976). Figure 1251 shows the result of the double section. Instead of making a linear osteotomy of the tibia Werndorff ("Wiener med. Woch.," lix, No. 23) excises a wedge of bone with its base anterior. This not only helps in correcting the deformity but provides a fragment of bone which he inserts into the cleft left in the femur after it has been divided and straightened (Fig. 1250).

III. **Cuneiform Osteotomy of the Femur.**—Expose the femur as in linear osteotomy, but make the incision through the soft parts more generous. With a chisel remove a segment of bone as in Figs. 1252 and 1253. This operation is calculated to correct a graver deformity than could the simple linear section.

IV. **Cuneiform and Trapezoidal Osteotomy of the Anchylosed Knee.**—It is presumed that the femur, tibia, and patella are fused into one bony mass.

Step 1.—Apply an elastic constrictor to the thigh. Expose the parts to be removed by a large U flap having its base directed upwards or downwards (it does not matter which).

Step 2.—With an amputating saw or with a very broad chisel excise a segment of bone. The upper cut through the bone should be nearly at a right angle to the axis of the femur, the lower cut nearly at a right angle to the axis of the tibia (Fig. 1254).

Step 3.—Attend to hemostasis. Place the divided surface of bone in apposition (Fig. 1255). Close the wound with sutures after providing drainage. Apply dressings. Immobilize. The divided ends of the bones may be kept in apposition by being pegged or sutured together or merely by means of the

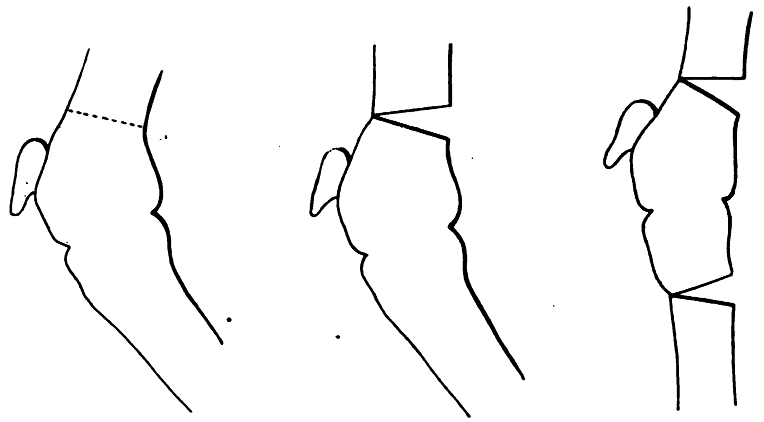


FIG. 1249. FIG. 1250. FIG. 1251.

FIGS. 1249, 1250 AND 1251.—Anchylosis of the knee.

immobilizing splint or dressing. The great objection to the above operation is the unavoidable shortening of the limb (*a*) from the removal of such a mass of bone, (*b*) from injury to, or destruction of, the epiphyseal cartilages in the young.

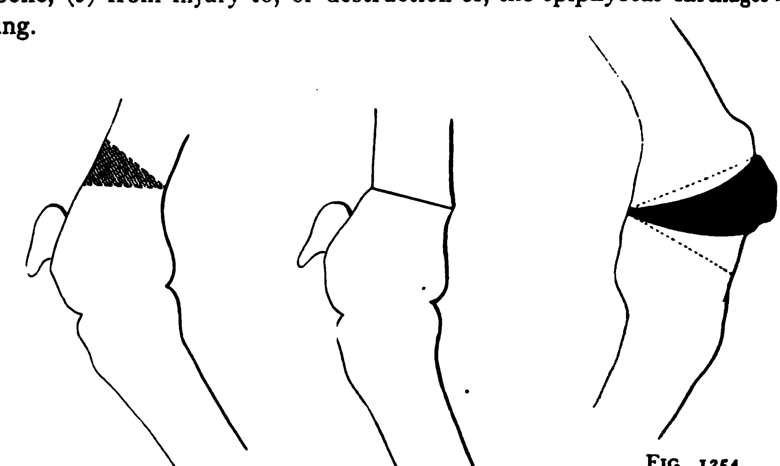


FIG. 1252. FIG. 1253. FIG. 1254.

Dotted line shows cuneiform osteotomy; shaded area shows curvi-cuneiform osteotomy.

FIGS. 1252, 1253 AND 1254.—Anchylosis of the knee.

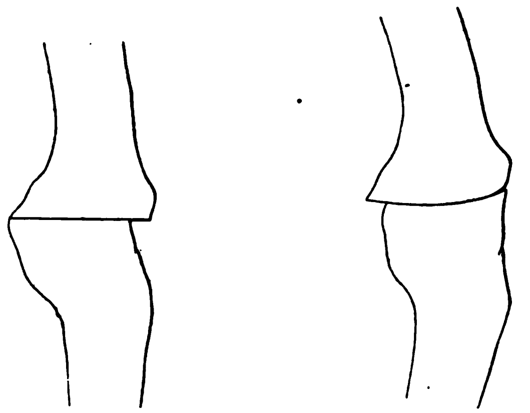
V. **Curvi-cuneiform Osteotomy.**—To avoid shortening inherent to ordinary cuneiform osteotomy of the knee Helferich ("Archiv für klin. Chir.," xli, 346; xlvi, 44[illegible]d a curvi-cuneiform operation.

Step 1.[illegible]elastic constrictor to the thigh. Expose the anterior and

lateral surfaces of the fused bones by a large U flap or by a transverse incision over the most prominent part of the deformity. Reflect the periosteum from the area of bone to be attacked.

Step 2.—Note the position of the epiphyseal line of the femur so as to avoid it. To find the line it may be necessary to shave off a thin slice of bone from the outer or inner side of the femur with a chisel. This exploration does no harm and may do much good. With a narrow-bladed finger-saw divide the extreme lower end of the femur in a curve corresponding to the antero-posterior curve of the condyles (Fig. 1254).

Make a similar curvi-linear section of the upper end of the tibia. The curve of the tibial section need not be so pronounced as that of the femoral. The result of the above is the removal of a curved wedge of bone; all that now



Cuneiform osteotomy — FIG. 1255.　Curvi-cuneiform osteotomy — FIG. 1256.

FIGS. 1255 AND 1256.—Anchylosis of the knee.

obstructs correction is the pressure of contracture of the ham-strings and of fascia (Fig. 1256).

Step 3.—Through short longitudinal incisions on each side of the popliteal space divide the ham-strings and any obstructing fascia. Remember the location of and avoid injury to the peroneal nerve between the biceps and the gastrocnemius. Instead of carrying out a mere tenotomy, it might be well to unite the divided ham-strings to the quadriceps tendon. Correct the deformity without using too much violence. Helferich noticed that in some cases complete correction interfered with the vascular supply of the leg; under these circumstances he contented himself with partial correction at the time of operation, but gradually straightened the limb during the after-treatment before solidification had time to take place.

Step 4.—The divided bones tend to remain in apposition. Apposition may be maintained by pegs, bone, or periosteal sutures, or by splints outside the dressings. Provide for drainage. Close the wound. Apply dressings. Immobilize. Place the limb in a position of great elevation. Remove elastic constrictor.

N. B.—If desired, the elastic constrictor may be removed before the wound is closed and hemostasis be effected by ligatures. In excision of the knee the author has found that elevation of the limb has always sufficed for hemostasis.

Anchylosis of Patella to Femur.—As an extreme rarity there may be bony anchylosis of the patella to the femur with complete integrity of the rest of the femoral articular cartilage. Immobility of course is the result. Helferich demonstrated the technical possibility of correcting this disability by division of the anchylosis and interposition of a flap of muscle. Cramer, without knowledge of Helferich's suggestion, made use of the same idea in a suitable case. Cramer's operation may be performed as follows:

Step 1.—Make a longitudinal incision on the inner side of the patella of length sufficient to give access to the line of anchylosis and to the lower part of the vastus internus.

Step 2.—With chisel and mallet separate the patella from the femur along the line of anchylosis.

Step 3.—Mobilize a flap of muscle from the vastus internus, the pedicle of the flap being inferior; tuck the muscular flap as smoothly as possible between the separated bones.

N. B.—Instead of a muscular flap, one of fat and fascia, as suggested by Murphy, may be used.

Step 4.—Close the wound. Dress. Begin exercises as soon as the wonud is healed.

Arthroplasty.—Before deciding on operation it is necessary to note:

1. The character of the anchylosis—whether fibrous or bony and whether the joint cavity is or is not obliterated.

2. The condition of the muscles which should move the joint. If they are insufficient or destroyed, operation is evidently useless.

3. The condition of the periarticular structures. If they are soldered together into a mass of scar tissue arthroplasty is impossible.

4. That the disease causing the anchylosis is cured.

5. The general condition of the patient.

The principles on which the operation of arthroplasty depends for success are the following. (Strict asepsis is assumed.)

1. Free exposure of the joint by incisions which will do least damage.

2. Liberation of the anchylosed surfaces by means of knife, scissors, saw, chisel, etc.

3. In case of bony anchylosis it is usually necessary to model the ends of the bone and to reduce their size. Payr recommends that this modeling be done on simple lines, no attempt being made to sculpture the end of the bone into its normal shape.

4. *Excision of all* the joint capsule as well as contracted bands of fibrous tissue and of ligaments. Both Murphy and Payr put much emphasis on this principle, and it certainly is based on common sense. Excision of ligaments and capsule not only aids directly in obtaining free motion, but indirectly also, as it means the removal of the articular nerve endings and thus minimizes post-

e pain and permits earlier and infinitely less painful motion. In ex-
ie capsule and ligaments where they are inserted in the bone it is wise
: away a piece of the bone with them.
revention of recurrence of the anchylosis. This is attempted by the
ition of pedunculated flaps of living tissue (fat-fascia; muscle; tendon;
sheath); free (*i.e.*, non-pedunculated) flaps or grafts of living tissue
synovial bursæ; cartilage, etc.); grafts of foreign structures, *e.g.*, hog's
prepared amnion, etc.
areful hemostasis. Avoidance of drainage except if necessary by aspira-
any effused blood after two or three
ayr). Most surgeons use drainage.
areful, methodical, persistent after-treat-

(“Münch. Med. Woch.,” lvii, No. 37)
gainst brusque passive movements as
ed to cause injury, and especially hemor-
hich can easily jeopardize the result de-
The same surgeon frequently prevents
by the ends of the bone on the inter-
issues by using direct extension by
f Steinmann's nails.
soon as the skin wound has united
the position of the joint frequently.
ie muscles in tone by massage, hot air,
lectricity, etc. Payr finds injections of
n, repeated every second day, service-

tle passive motion should be begun at
id, what is of greater value, active mo-
Tendon transplantation may be neces-
reinforce weakened muscles.

Fig. 1257.—Arthroplasty. (*Murphy.*)

phy's Operation.—Many researches
hose, Langemak, Thorn, Franz, etc.)
oved that ganglia and bursæ are the re-
a degeneration of connective tissue and
e synovialis of joints is formed origin-
identically the same process. J. B.
, accepting these truths, applied them to the operation of arthro-
Applied to the knee-joint, his operation is as follows:
1.—Apply the elastic constrictor high up on the thigh. Make an ex-
ngitudinal incision from a point 6 inches above to a point 3 inches below
e-joint (Fig. 1257). Do not incise the deep fascia except to the extent
y for opening the joint for overcoming the anchylosis. Make a 4-inch
incision over the inner side of the joint.

Step 2.—With scalpel, chisel, or saw, free the patella from the femur. Do *not* divide the ligamentum patellæ or the quadriceps tendon.

Step 3.—Thoroughly divide and *remove* the lateral ligaments of the knee. Murphy lays great stress upon this step.

Step 4.—(*a*) If anchylosis is fibrous, break or divide the adhesions. (*b*) If anchylosis is bony, divide the bone with chisel or saw and shape the ends of the femur and tibia in such a manner that the lower end of the femur is convex and the upper end of the tibia is concave from before backwards.

Step 5.—Dissect a large flap of fascia lata, with a thin layer of muscle attached, from the outer surface of the vastus externus (Fig. 1258). The base or pedicle of the flap is below and in front. The flap must be long enough to pass through and project from the inner side of the joint, and large enough to envelop the sawn surface of the femur. Pull the flap through the joint; spread it over the lower end of the femur; fix it in position by a few catgut stiches.

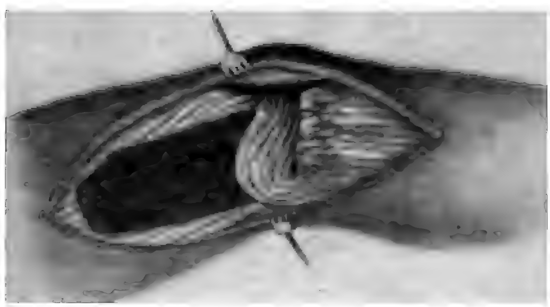


FIG. 1258.—Arthroplasty. (*Murphy.*)

Step 6.—In a similar manner prepare a smaller flap of fascia and interpose it between the patella and the femur.

Step 7.—Close the wound. Provide for drainage. Dress. Immobilize in the extended position. Massage and gentle passive motion may be begun after the first week. One patient operated on by Murphy has obtained good use of the knee without the necessity of any supporting apparatus.

Davis's Operation.—In a woman of 23 with bony anchylosis of the knee, the result of general articular rheumatism, G. G. Davis ("Am. Journ. Orthopedic Surg.," iv, p. 379) made use of Murphy's methods as follows: "Two long incisions were made on the sides of the joint and two rectangular flaps about 4 inches long, consisting of fat and fascia lata, turned down. The patella was sawn loose from the femur horizontally and then a wedge-shaped piece of bone excised, 2½ inches (6 cm.) long on its anterior side and 1½ inches (4 cm.) long on its posterior side. The end of the femur was sawn slightly convex and the end of the tibia slightly concave. One flap was turned in under the patella and over the femur and the other drawn transversely over the sawn surface of the tibia and fixed by a few catgut sutures. The limb was put up in an ex-

ended position in plaster. Healing by primary union except at drainage-tube opening, which remained open perhaps three or four weeks. When healing was complete an apparatus consisting of two side irons and a screw mechanism to limit the movement of the joint was applied. Movement was so free from the start that the screw was discarded and she was sent home on crutches. It is now nine months since the operation. The joint can be readily extended straight and flexed at a right angle. The apparatus is essential to give stability to the joint."

The author saw the patient two years after operation. Aided by the apparatus, the patient walks well and comfortably.

Payr's Operation.—Payr's method of operating is in all essentials like that of Murphy and Davis. Occasionally he provides artificial lateral ligaments of silk and usually keeps the surfaces of the bone apart by weight and pully traction exerted directly on the upper end of the tibia by means of nails screwed into the bone (p. 917).

Implantation of Animal Membranes.—Baer ("Johns Hopkins Bulletin," Sept., 1909) made experiments with the implantation of Cargile's membrane in joints, but found that it was too delicate and too soon absorbed. Pig's bladder properly prepared and chromicized to last from thirty or forty days is sufficiently durable, plicable and tough to answer the purpose. The knee-joint is opened by lateral incisions, the anchylosis removed and the membrane applied so as to be adapted to the whole contour of the joint and fixed in place by sutures. "Every raw surface should be absolutely separated by it from that with which it would normally come in contact." With the same object, portions of hernial sac or of amnion (Hermann Schmerz, "Zent. f. Chir.," Oct. 14, 1911), washed in salt solution and preserved in 2 per cent. formal solution, have been employed.

Joint Transplantation for Anchylosis of Knee.—E. Lexer ("Archiv für klin. Chir.," lxxxvi, 952) in 1908 described two cases in which he transplanted the entire knee-joint. The following is a very free translation of Lexer's description. "One of these two cases was submitted to operation seven, the other four, months ago. In both there was synostosis with marked flexion, due, respectively, to suppuration and to tuberculosis. To expose the joint I formed a large flap in front, having its convex lower end at the level of the tuberosity of the tibia, so as to permit reflection of the remnants of the ligamentum patellæ and of the articular capsule with the flap. Only in the first case was the ligament present, while in both the capsule was destroyed. After exposing the synostosis in front, the soft parts, including the tendon insertions, were separated from the bones, both laterally and posteriorly, by sharp and blunt dissection. The sclerosed periosteum remained attached to the bone. The anchylosed joint was now excised in such a manner as to aid in reestablishing good position. In each case the defect left between the femur and tibia, when the limb was straightened, was about three finger's breadth in extent. The knee was now excised from a freshly amputated limb. The portion used for transplantation consisted of the entire articular surfaces and about 1½ fingers'

breadth of bone belonging to the femoral and tibial epiphyses. In both cases the crucial ligaments were intact; in the first case the semilunar cartilages were removed, while in the second case these were retained as were also the lateral insertions of the capsule. When the implant was placed in position it was fixed to the tibia and femur by means of nails or wire.

"The ligamentum patellæ, preserved in one case, was sutured to the periosteum. Healing took place in both cases. In the first case passive motion was impossible because the patella had been merely reflected and replaced at the operation without having its under surface protected by interposed material, and so it became adherent. Three months later the patella was excised." During this second operation the implant was inspected and proved to be solidly in place and alive. Both patients have a small degree of motion (in one passive flexion to about 45°), and pain *neither* on walking nor standing. There is no lateral motion.

Remarks.—On reading Lexer's most delightful and brilliant article one is reminded of the famous recipe for making hare soup, which began with the words "first catch your hare." It is only fair to state that in Lexer's clinic there seems to be a large number of cases of senile gangrene without phlegmon, and it is from that source that he obtains his material for implantations.

Juxta- or Supra-articular Osteotomy.—Perkins' Operation.—This operation, devised and carried out by J. W. Perkins, is applicable to similar conditions in various articulations, but is perhaps peculiarly appropriate in the knee. The principles of the operation are: (*a*) Avoidance of injury to the articular structures and, in the young, to the epiphyseal line. (*b*) Avoidance of injury to, or undue stretching of, the great vessels and nerves of the popliteal space. (*c*) Rectification of deformity with retention of any power of movement which the joint may possess.

The operation is an extension of the basal principles of Macewen's supracondyloid osteotomy.

Example 1.—The knee is in a position of flexion; a moderate degree of further flexion is possible but no further extension. The structures (ligaments, tendons, vessels, etc.) posterior to the knee are contracted.

The Operation.—*Step* 1.—Make a longitudinal incision 2½ to 3 inches in length down to the bone on the inner side of the thigh. The lower end of this incision should be about ¼ inch above the epiphyseal line. If necessary, make a similar incision on the outer side of the thigh.

Step 2.—Separate the periosteum from the bone and retract the soft parts and periosteum together so as to expose a sufficient area of bone.

Step 3.—With osteotome, chisel, or saw excise the rhomboid of bone ab, cd (Fig. 1259). The segment of bone removed must be sufficient to permit the limb to be straightened. The short side of the rhomboid (ac) must be long enough so that when the limb is straight the structures behind the knee are not unduly stretched.

Step 4.—Straighten the limb (Fig. 1260). Close the wound with or without drainage. Treat as a fracture.

›sgood (Surg., Gyn., Obst., xvii, 664) describes an operation very similar ıat of Perkins.

:xample 2.—**Genu Recurvatum.**—The knee is in a position of hyperexten- (dorsal flexion). Further extension (dorsal flexion) is possible, but only ; to the deformity and disability. Operate as in Example 1, but make the of the rhomboid *posterior* instead of anterior (Fig. 1261). Remove so much : that when the divided ends of bone are put in apposition the whole limb is ight while the knee-joint is in its position of greatest hyperextension (Fig.). Shortening of the flexor tendons of the knee may be necessary.

Vreden's Operation.—("Russki Wratsch.," 1910, No. 6, Ref. "Zentralblatt Chir.," 1910, No. 22.) Occasionally some motion remains in a knee which

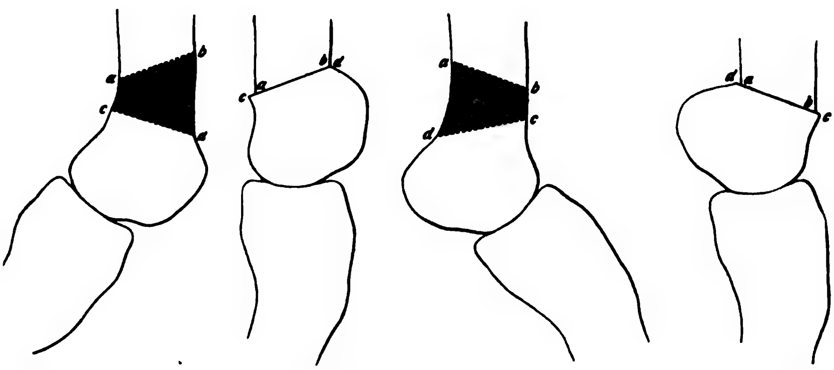


FIG. 1259. FIG. 1260. FIG. 1261. FIG. 1262.

FIGS. 1259, 1260, 1261 AND 1262.—Perkins's operation.

ecovered from tuberculous disease but is in a position of flexion. In these Wreden's operation may be used.

hrough an appropriate incision (Wreden uses a Y-shaped incision) expose· lo not open the upper synovial pouch of the knee. Reflect downwards the vial pouch along with the periosteum of the femur. Divide the femur versely close to the knee; make the lower end of the shaft of the femur pro- : from the wound and with a saw "sharpen" the end of the bone like a lead il. In the sawn surface of the epiphysis construct a hole suitable to receive ›ointed end of the diaphysis. Push the end of the diaphysis, like a peg, into ıole in the epiphysis after straightening the limb. The principle of the ation is the same as that of Perkins' method.

CHAPTER LXXXV

DISLOCATION OF THE PATELLA

Recent outward dislocation of the patella may be irreducible without
tion when the ligamentum patellæ becomes caught under the external cond
the femur, or when there is such rotation of the patella on its long axis t
cartilaginous surface faces forwards. A longitudinal incision made to th
side of the patella permits of reduction and at the same time gives an
tunity to suture the torn inner capsule and any fibres of the vastus in
which may be ruptured.

In old unreduced patellar dislocations there is always lateral elongat
the capsule on one side of the bone and there may be cicatricial contract
the other side. (The dislocation is almost always outwards, hence the e
tion of the capsule is on the inner side.) If disability is marked, opera
demanded.

Make an incision to the inner side of the patella and open the join
possible reduce the dislocation and shorten the elongated capsule lat
either by excising an elliptical segment and closing the wound by sutures
closing the original longitudinal wound in such a fashion as to make one
of the wound overlap the other. If contraction of the outer portion of th
sule renders reduction by simple arthrotomy impossible, a longitudinal in
may be made through the contracture. Access to the portion of caps
fault may be obtained, according to circumstances, (*a*) through the or
wound, through the joint cavity, under the patella, the capsular division
made from within outwards; (*b*) through the original wound by dissectin
skin from over the patella, retracting the skin and cutting the capsule from
out inwards; (*c*) through a special incision.

If hemostasis is complete close the wound without drainage, otherwise
a drain of rubber tissue or oil-silk for about twenty-four hours. Dress. I
bilize in a semi-flexed position until the wound has healed. After two
begin massage and passive motion. Walking may usually be begun in
five weeks.

Recurrent or Habitual Dislocation of the Patella.—When orthopedic ap
tus proves inefficient or inconvenient, operation is indicated.

The principal conditions favoring the occurrence of habitual dislo
(Hildebrand) are the following:

1. External condyle absolutely or relatively less prominent than in
condyle.
2. Patellar fossa too small.
3. Genu valgum.

4. Abnormal external rotation of the lower leg.

5. Abnormal laxness of the quadriceps femoris or of the ligamentum patellæ.

6. Injuries of the capsule, tears of the capsule or of the vastus internus or its tendon which have healed and stretched.

7. Stretching of the capsule in genu valgum, *e.g.*, occasioned by hydrops, etc. A longitudinal incision along the inner side of the patella down to, but not through, the joint capsule permits examination as to its laxity. If laxity of the capsule is the main lesion, it is easy (*a*) to excise an ellipse from it and close the wound with sutures, (*b*) to incise the capsule and close the wound in such a fashion that one edge overlaps the other, or (*c*) to catch the *unopened* capsule in forceps, throw it into folds and fix these folds with sutures.

If the dislocation is due to improperly united tears of the vastus internus and its tendon, the same longitudinal incision exposes such, and they may be so repaired that the muscle can once more act properly on the patella. Traumatic hydrops may cause habitual dislocation in a knock-kneed subject. Osteotomy correcting the knock-knee has cured the dislocation (Hildebrand). Hildebrand reports a case in which there was a flattening of the external condyle but no knock-knee; when the knee was extended there was incomplete luxation, but in flexion the luxation disappeared. The tuberosity of the tibia was transplanted inwards; the result was excellent.

The above hints show that in habitual dislocation of the patella the surgeon must not be governed by hard and fast rules, but must as far as possible be guided in his treatment by a study of causation.

FIG. 1263.—Goldthwaite's operation.

Goldthwaite's Operation.—In uncomplicated cases of recurring dislocation of the patella Goldthwaite's operation, either alone or plus capsulorrhaphy, is excellent.

Step 1.—Expose the tendo patellæ freely through a longitudinal incision.

Step 2.—Split the tendon longitudinally. Divide the inner half of the tendon transversely at its insertion into the tibia thus forming a tendon flap which has its base above the patella.

Step 3.—With closed scissors or forceps burrow under the inner (intact) half of the patellar tendon, pull the mobilized flap of tendon through this tunnel and unite it by sutures to the periosteum and to the expansion of the tendon of the sartorius muscles (Fig. 1263).

Whitelocke's Operation—(Brit. Journ. Surg., II, 12).—1. Reflect a large, horseshoe-shaped flap of skin and fascia with its base in front and its apex reaching backwards to the line of the medial ham-strings. The base of the flap corresponds to the medial margins of the patella and its ligament.

2. Expose the ligamentum patellæ for about ¾ inch [illegible]rate it for about ½ inch in the middle line.

3. Recognize the Sartorius muscle by the directio[illegible]lar fib[illegible] Divide the fascial attachment of this muscle above as[illegible]ret[illegible]

posterior edge forwards to expose the tendon of the gracilis which lies proximal to the semitendinosus. Free the gracilis from its surroundings, being careful not to injure some vessels and a nerve which run parallel to it. Divide the gracilis as close to its tibial insertion as possible. At its insertion the tendon spreads out into a thin expansion about 2 inches in vertical diameter.

4. Pull the end of the tendon from behind forwards through the split already made in the ligamentum patellæ and fix it there with sutures (Fig. 1264). The tendon in its new position passes almost horizontally forwards around and over the internal tuberosity of the tibia. With a few stitches, which should not penetrate the joint, anchor the tendon in its new course to the articular capsule. Repair the connections of the edge of the Sartorius which were dissected in exposing the gracilis.

If the gracilis is not long enough to reach, without tension, to the ligamentum patellæ, it is easy to mobilize a flap of that ligament and sew its free end to the end of the gracilis tendon.

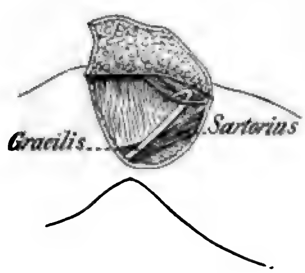


Fig. 1264.

5. Close the wound. Dress. Apply a posterior splint for about ten days or until the wound has healed.

Wullstein's Operation.—In a severe case of external congenital dislocation of the patella Wullstein ("Zentralblatt für Chir.," 1906, No. 38) found that the inner portion of the joint capsule was excessive in quantity while the outer was correspondingly narrow. He operated as follows:

Step 1.—By means of a horseshoe-shaped incision reflect upwards a very large flap of skin from over the knee-joint and thus expose the anterior and most of the lateral aspects of the joint as well as the ligamentum patellæ to below the tibial tuberosity and the quadriceps tendon to a point above the superior recess of the synovialis.

Step 2.—By blunt dissection separate the quadriceps tendon and the ligamentum patellæ from the underlying portion of the joint capsule.

Step 3.—To the outer side of, and about ¼ inch from the patella incise the capsule (both fibrous and synovial) along the line c d (Fig. 1266). Make the corresponding incision A B (Figs. 1265 and 1266) on the inner side of the patella. Retract and elevate the quadriceps muscle and tendon from the upper recess of the synovialis and continue the incision A B and C D upwards to meet at the point E corresponding to the highest part of the joint cavity. Elevate or retract the ligamentum patellæ and continue the incisions A B and C D downwards to meet at the point B.

Step 4.—Push the patella inwards to the extent necessary for correction of the deformity. Note how much of the inner portion of the capsule is excessive and guided by that information make the incision X Y (Fig. 1265) parallel to A B. Retract the vastus internus and continue the cut X Y under the vastus to the point Z.

Step 5.—The incisions F B A E and Y X Z from a flap Q of joint capsule on the inner side of the joint. Transfer the flap Q under the patella from the inner to the outer side of the joint. When the patella is pushed into its correct position the wound made by the incision E C D B (Fig. 1266) gapes. Into this defect on the outer side of the joint suture the flap Q.

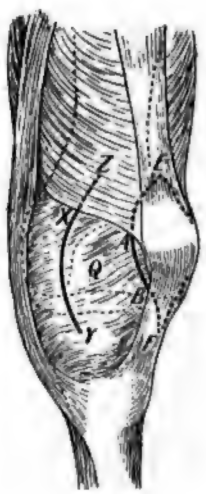


FIG. 1265.

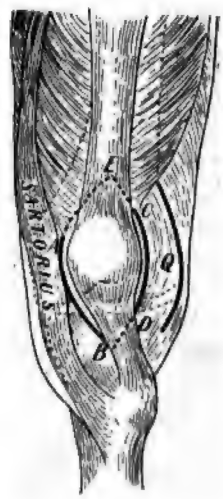


FIG. 1266.

FIGS. 1265 AND 1266.—Wullstein's operation. (*Wullstein.*)

Step 6.—Suture the capsular wounds.

Step 7.—Mobilize the sartorius muscle and suture its outer edge to the inner edge of the patella. This aids in keeping the patella in position.

Step 8.—Close the wound. Dress. Immobilize.

CHAPTER LXXXVI

ANKLE

Puncture and Injections.—Krause recommends that the trocar punctu tissues vertically immediately below one or the other malleolus and the its point be directed upwards. If injections are necessary they may be more definitely through an arthrotomy incision than by means of the The material used for injection varies (carbolic solution, formalin-gly iodoform in glycerine, oil or ether, etc.).

Arthrotomy.—*Step* 1.—Make a 2-inch vertical incision along the a border of the external malleolus and ending about ½ inch below the the malleolus. The extensor tendons and the peroneus tertius lie to th side of the incision. Divide the annular ligament. Open the joint diately in front of the malleolus.

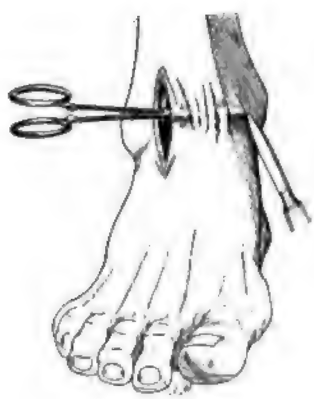


FIG. 1267.

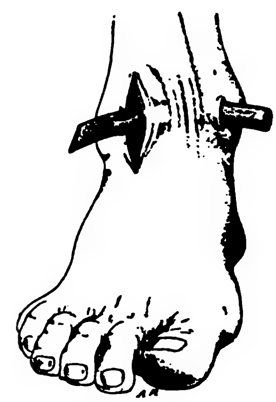


FIG. 1268.

FIGS. 1267 AND 1268.—Drainage of the ankle. (*Lobey*.)

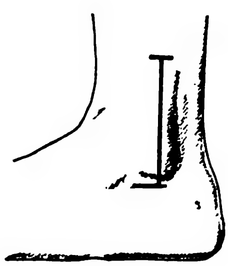
Step 2.—Pass a closed forceps through the above incision across th to the inner side of the limb (Fig. 1267). The forceps must be in conta the bone, must pass through the joint itself and so lie behind the sy sheath of the extensor tendons. Make the point of the forceps raise t parts immediately in front of the internal malleolus. Divide the soft par the point of the forceps. With the forceps pull a tube through the join 1268).

If instead of draining the joint it is desired to fill it with iodoform emul such like material, this may be done through the incision and the wound with sutures.

p 3.—If the single or double anterior arthrotomy wound is insufficient inage, it is easy to make a posterior counterpuncture on the outer side of ndo achillis. If it is necessary to incise on the inner side of the tendo , remember the position of the posterior tibial vessels and nerve as well flexor tendons of the foot and avoid them.

:ision of the Ankle.—Langenbeck's Subperiosteal Resection of the —Lay the foot, inner side downwards, on a firm sand bag. On the pos- margin of the fibula make a longitudinal incision 1½ to 2½ inches in directly to the bone. The lower end of the cut is opposite the tip of the lus. Some surgeons prefer an I-shaped incision on the outer surface of the (Fig. 1269).

:h periosteal elevator separate the periosteum and soft parts together he external and anterior surfaces of the bone. At the lower end of the lus it is necessary to supplement the blunt dissection by cutting with



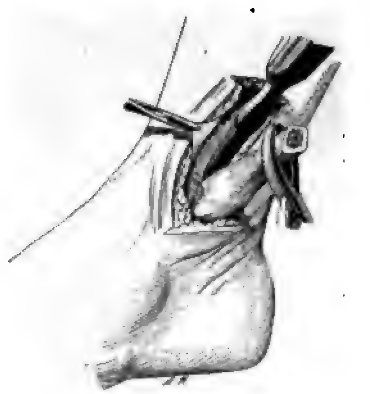


FIG. 1269. FIG. 1270.

FIGS. 1269 AND 1270.—Excision ankle. (*Labey.*)

or knife. In cutting, the edge of the knife or the point of the scissors e directed against the bone to avoid injury to the periosteum and soft This shelling of the soft parts from the bone is carried forwards to the d insertion, which is also separated from the bone.

imilar fashion clear the posterior surface of the fibula of its coverings e interosseous ligament is reached and divided. The ligament should be as little as possible. Chose the point at which it is desired to divide the Protect the soft parts with a retractor or periosteal elevator and divide e with a Gigli wire saw or chisel (Fig. 1270). Seize the upper end of the f portion of bone with lion forceps, pull it outwards, divide or separate all ns with the elevator, knife, or scissors and rem[illegible] bone. Lay the its outer side. Make a vertical incision from [illegible] internal mal- pwards for 2½ inches along the middle line of [illegible] desired one pplement the vertical by a [illegible] curved [illegible] nd or ansverse incision at [illegible] ame

time as the skin. With straight and curved periosteal elevators separate the periosteum and all structures superficial to it (tendons, vessels, nerves, etc.) from the bone. Divide the tibia with a saw or chisel at the same level, if possible, as the fibula. With forceps pull the lower fragment of bone outwards and downwards, at the same time severing its connections to the interosseous membrane and articular capsule with the periosteal elevator, knife, or scissors. Remember always to cut *against* the bone so as to avoid unnecessary injury. Remove the bone.

Fig. 1271.—Excision of ankle.

(Ollier advises that the bones should be divided obliquely; the line of section being from above and within, downwards and outwards. He states that by so proceeding greater solidity of the ankle results.)

Examine the astragalus. If it is diseased, but not to a serious extent remove the diseased tissues with the sharp spoon or chisel. With forceps and scissors trim away ragged and loose pieces of cartilage. If it is necessary to remove the whole superior portion of the body of the astragalus this may be accomplished with the chisel or saw. If the saw is used the soft parts must be protected by using suitable retractors or by holding them aside and covering them with periosteal elevators. Pack the cavity of the wound with iodoform gauze leaving the incisions open, or partially close the incisions with sutures and provide tubular drainage. If no secondary infection is present, the wound cavity may

led with Mosetig's iodoform plug or some equivalent and closed without age. Dress. Immobilize with plaster of Paris. While the plaster is :ning the foot must be held in a position at right angles to the leg and er everted nor inverted. If much shortening is expected the foot may be in a position of slight plantar flexion.

önig's Operation.—König's operation gives admirably free access to the -joint and is specially indicated in tuberculous disease where it is impor- to expose, observe, and treat not merely the ankle itself but the bones and ; which lie near it. From a point on the anterior margin of the tibia 1½ to nches above the ankle-joint and immediately internal to the extensor ten- make an incision downwards and forwards over the articulation, over the side and neck of the astragalus to end in front of the prominence of the ıoid. On the outer side of the ankle make a similar incision along the ior surface and margin of the fibula, across the articulation and ending on

FIG. 1272.—Excision of ankle.

uter side of the cuboid at the level of the astragalo-scaphoid joint. With ps, knife, and elevator separate the whole bridge of tissue between the two from the underlying bones (Fig. 1271). If the case is one of tuberculosis, he foot in a position of dorsal flexion, lift the tissue bridge out of the way a blunt hook, examine the whole anterior articular region, remove, by :tion, the anterior synovialis, and, if a partial operation will suffice, remove liseased bone with chisel and spoon. König writes: "If a large focus is nt in the astragalus there is always danger that the three neighboring ; are affected and one must, as a rule, remove the astragalus. The removal be effected through either incision, preferably through the inner, by the use 'ceps, scissors, and knife with the assistance of strong periosteal elevators." the astragalus is removed a good view can be had of neighboring structures 'rom them diseased foci, if limited in extent, may be removed.

before the astragalus is removed it is known that the malleoli ought to cised one proceeds as follows:

Make the incisions as already described down to the bone, but althoug dividing the periosteum do not separate it from the malleoli (Fig. 1172). Intr

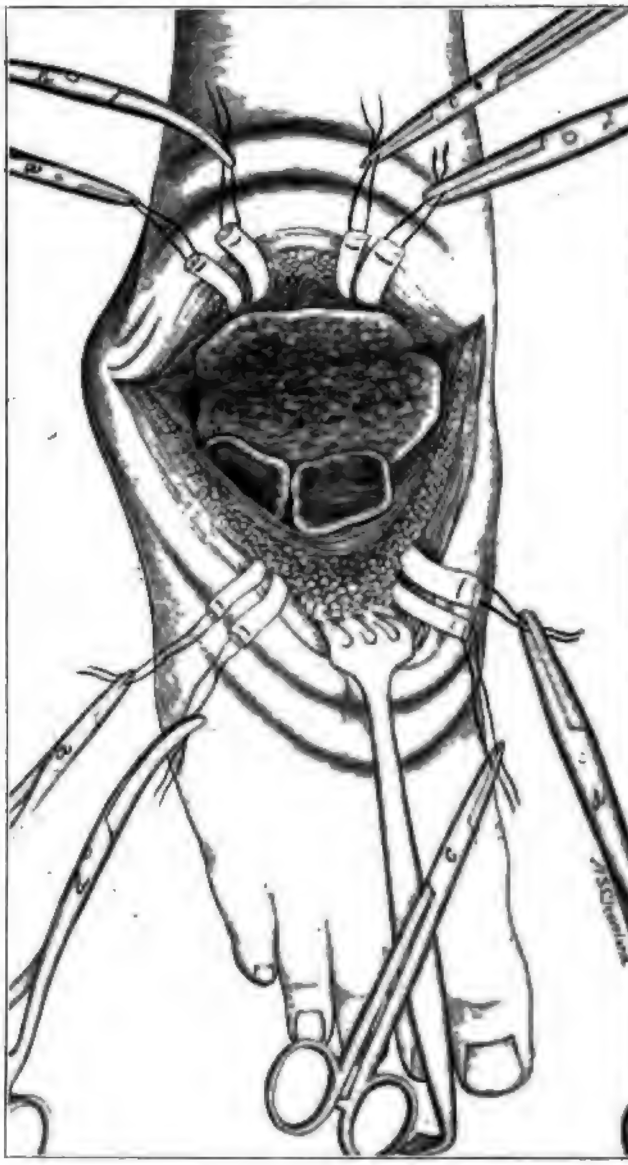


FIG. 1273.—Excision of ankle. (*Ochsner.*)

duce a broad-bladed chisel into the wound and cut from the outer surface o the malleoli a thin shell of bone. This osseous shell is covered by its periosteur which is continuous above with the periosteum of the tibia or fibula as the cas

may be and below with the lateral ligament. Retract the shell of bone outwards along with its attachments, divide the rest of the bone transversely with the chisel, and remove the fragment. The rest of the operation is to be carried out as already described. By the above procedures even the calcaneal and scaphoid joints can be reached and treated.

The active operation being ended, clean the wound cavity and rub it with iodoform, provide drainage either with tubes or iodoform gauze, partially close the wound with sutures, press the loosened shells of bone inwards, and apply dressings. As an alternative, fill the cavity with Mosetig's iodoform wax and close without drainage. Immobilize with plaster of Paris as in Ollier's operation. As anchylosis is desired, the after-treatment consists in keeping the parts at rest until they have become firm. If sinuses form and persist they must be dilated or opened and their cause removed.

Ochsner's Method.—Operation.—An incision is carried directly across the anterior surface of the ankle from malleolus to malleolus through the skin superficial and deep fascia and the sheaths of all the tendons in the course of the incision. Externally the peroneal artery and nerve should be avoided, as well as the tendons of the peroneal muscles, which can readily be drawn out of the way. Internally the posterior artery and nerve should be protected. Each tendon is then lifted up in the incision and transfixed with two fine catgut sutures from 1 to 2 centimetres apart. These sutures are caught in similar artery forceps for purposes of identification, then the tendon is cut transversely between these sutures (Fig. 1273). After all the tendons have been disposed of in this manner, the joint is opened by a free transverse incision and the sole of the foot is forced back upon the calf of the leg. In this manner the entire joint is opened freely, so that all diseased tissue can be removed. After this has been accomplished, the foot is placed in position, the tendons are carefully adjusted, which can be done with great ease, because the two sutures upon two corresponding tendon ends are fastened to hemostatic forceps of the same pattern. Each tendon is carefully sutured and a fine stitch is placed in the fascia to cover the line of suture in the tendon. Then the skin is sutured over all. If drainage seems necessary, this is applied through and through, and even in cases apparently requiring no drainage, I have usually passed a few strands of catgut or silkworm-gut entirely across the foot, permitting the ends to protrude from the lower angles of the wound in order to drain the serum which may be secreted by the large surface during the first few days. A large dressing is applied and the foot is immobilized in a position at a little less than right angle.

After-treatment.—The foot is elevated in order to favor return circulation. If drainage has been employed, this is left in place from one to two weeks. The dressing is not changed, unless this is indicated by the discharge, for a week or ten days, in order to avoid moving the foot, and after that as seldom as possible for the same reason.

Prognosis.—The prognosis is very good after this operation. The free exposure of the surfaces insures thoroughness, and consequently the cure is usually permanent. The anchylosis of the surfaces immediately in the field

conservative treatment and minor operations fail.

CHAPTER LXXXVII

DISLOCATION OF THE ASTRAGALUS

Occasionally the astragalus is dislocated from both its superior and inferior connections. Reduction always requires a general anesthetic, and as failure to reduce by manipulation is probable, the surgeon ought to be prepared to operate at once. The bone so presses upon the soft parts that gangrene of the skin is sure to result, unless reduction is effected or the bone excised.

Make an incision on the inner side of the ankle from a point 1 inch above the articular surface, just in front of the malleolus, downwards and forwards to the internal cuneiform bone. Avoid injury to the tendon of the tibialis anticus. Separate and retract all the soft parts covering the astragalus. Endeavor to effect reduction by exerting traction on the foot and pressure on the astragalus. If this fails, and if more free access promises some prospect of success, make a corresponding incision on the outer side from just above and in front of the external malleolus downwards and forwards to the cuboid. Expose the parts involved. Once more attempt reduction. If the attempt still fails, remove the astragalus. Astragalectomy gives such good results that it is foolish to run much risk in striving after the more ideal operation. If the astragalus is completely separated from its connections or nearly so, then its removal must be the rule. When the dislocation is complicated by fracture and especially when it is compound (open) and infection is probably present, astragalectomy followed by drainage is the procedure of choice.

Katzenstein.—("Zent. für Chir.," 1912, No. 6.) In a chronic or recurring dislocation at the astragalo-navicular joint due to rupture of the tibio-navicular ligament and causing much disability, pain and flat foot, Katzenstein obtained a perfect anatomical and functional result by the following operation: Reduce the dislocation; expose by incision the surface of the internal malleolus and the navicular bone; from the tibia or any convenient bone, obtain a non-pedunculated flap of periosteum, fold this flap transversely so that its periosteal surfaces are in apposition except at both extremities; vivify a small surface on both the internal malleolus and the navicular bone and to these surfaces suture the ends of the periosteal flap; close the wound; immobilize in a position of valgus. After 5 or 6 weeks begin passive and later active motion.

CHAPTER LXXXVIII

SUBASTRAGALOID DISLOCATION

If manipulation under an anesthetic fails to reduce, operation is demanded. Baumgartner and Huguier ("Revue de Chir.," Aug., 1907) divide the cases requiring operation into two classes according to whether the astragalus is or is not fractured.

I. **The Astragalus is not Fractured.**—Reduction by arthrotomy is the operation of choice. Make an incision directly over the prominent head of the astragalus. Recognize the structures obstructing reduction. If these are ligamentous bands, divide them in one or more places (Quénu); if they are displaced tendons (*e.g.*, the tendon of the tibialis anticus sometimes lies along the inner and upper part of the neck of the astragalus which is then tightly held between it and the calcaneo-scaphoid ligament) (Stimson) the tendons may be pushed aside, or if this is impossible they may be divided and reunited after reduction is obtained.

Reduce the dislocation by manipulation, especially by flexing the foot, and by direct pressure. Close the wound with sutures. Dress. Immobilize for about three weeks. If reduction by arthrotomy fails, it is easy to proceed to astragalectomy, either complete or incomplete. Only so much of the astragalus ought to be removed as will permit of the foot being placed in a good, useful position.

II. **The Astragalus is Fractured as well as Dislocated.**—(*a*) The fracture affects the neck alone. The separated and dislocated head of the bone may be reduced or removed according to circumstances.

(*b*) The body of the bone is fractured. Astragalectomy is usually the best procedure to adopt. In compound (open) dislocation the indications for operation are much the same as given above. Astragalectomy, then, is indicated in cases of subastragaloid dislocation, (1) when the luxation is irreducible or operative reduction has failed; (2) when infection is present; (3) in old cases.

CHAPTER LXXXIX

OS CALCIS

Exostoses on the Plantar Surface of Os Calcis.—Exostoses in this position (Figs. 1274, 1275) are not extremely rare, but may be disabling on account of pain. Operation is demanded when relief is not obtained by the use of a cushioned heel. Make an incision along the inner side of the foot close to the

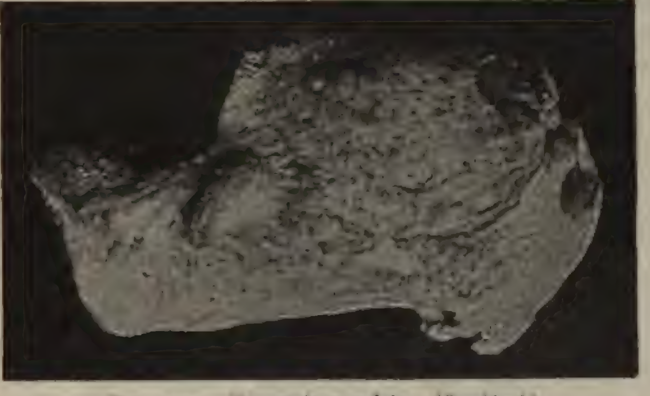


FIG. 1274.—Exostosis os calcis. (*Bradford.*)

sole and opposite the site of exostosis. By sharp and blunt dissection expose the affected portion of os calcis.

With a chisel remove the bony spur. Close the wound with or without drainage.

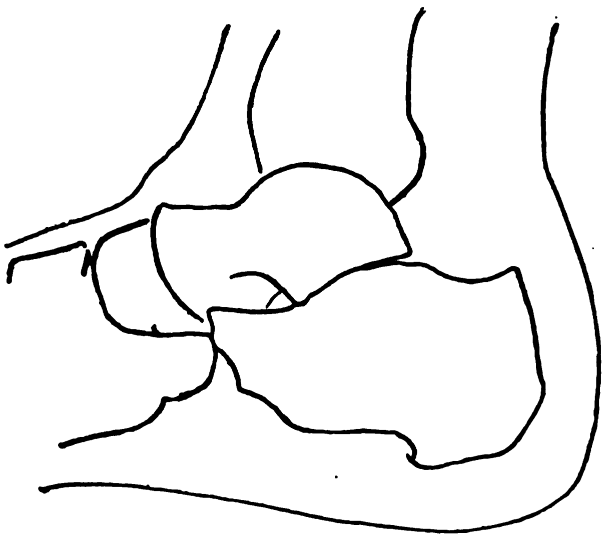


FIG. 1275.—Exostosis os calcis. (*Bradford.*)

CHAPTER XC

BUNION

HALLUX VALGUS

Hallux valgus consists in an inward* deviation of the great toe, the last phalanx of which may lie transversely across the second toe. The head of the metatarsal bone is pushed outwards, is usually enlarged, and part of its articulating surface is no longer apposed to that of the phalanx. Between the bone and skin there is a bursa formed which frequently becomes inflamed (bunion).

Dwight has described a supernumerary bone which occasionally exists between the bases of the first and second metatarsals. To this bone he has given the name intermetatarseum. The intermetatarseum may be free or may be fused with the first or the second metatarsal or with the internal cuneiform bone. J. K. Young believes that Dwight's bone is the cause of some forms of hallux valgus and if detected by the X-rays in an early case of deformity its removal should arrest the condition and relieve all symptoms. Young has performed the operation on a case of six years' duration.

Barker's Operation (Metatarsal Osteotomy).—Support the outer side of the foot on a sand-bag.

Step 1.—Make an incision directly to the bone, about one inch long, over the prominence of the metatarsal head, on the inner side of the foot.

Step 2.—With a chisel divide the metatarsal bone transversely at a point about ½ inch from the head. If the deformity is great instead of simply dividing the bone, excise a wedge from it.

Step 3.—Straighten the toe. Apply dressings. Immobilize.

Hueter's Operation (Metatarso-phalangeal Arthrectomy).—*Step* 1.—By manipulation locate the metatarso-phalangeal joint. Make a longitudinal incision on the inner side of the foot sufficient to expose the joint and the immediately adjoining bones.

Step 2.—With a chisel shave off sufficient of the articular ends of the metatarus and phalanx until correction of the deformity is easy.

Step 3.—Close the wound. Apply dressings. Immobilize in correct position.

Riedl's Operation.—Osteotomy of the Cuneiform Bone.—*Step* 1.—Make a longitudinal incision on the inner side of the foot sufficient to expose the internal cuneiform bone and its articulation with the first metatarsal.

Step 2.—Avoiding injury to the insertion of the tibialis anticus, cut a wedge of bone from the cuneiform. The wedge must have its base on the external (fibular) side (Fig. 1276). The thickness of the wedge corresponds to the amount of metatarsal adduction.

* The word "inward" is used in relation to the middle line of the foot.

Step 3.—Through the wound in the bone with strong scissors or kni around the external angle of the base of the first metatarsal bone so mobilize it.

Step 4.—Place the metatarsal bone in correct position (Fig. 1277).

Step 5.—Correct the position of the great toe by some of the m described.

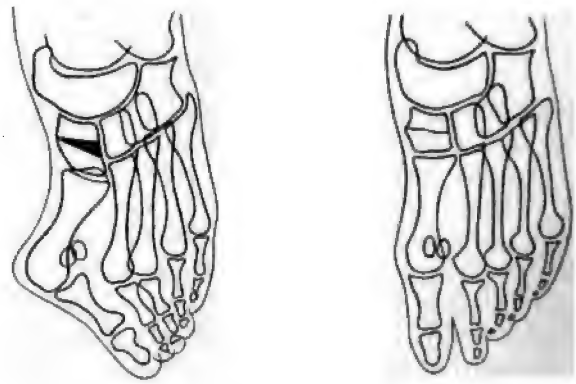


FIG. 1276.—Bunion. Riedl's operation. (*Riedl.*)

Step 6.—Attend to hemostasis. Apply dressings. **Immobilize.**

Riedl's operation is only suitable in cases of very **great deformity** o first metarsal when rectification at the metatarso-phalangeal **articulation** w be insufficient.

Robert F. Weir's Operation.—On the inner side of the foot **make a** l tudinal curved incision beginning "in front at the hollow of **the phalanx**

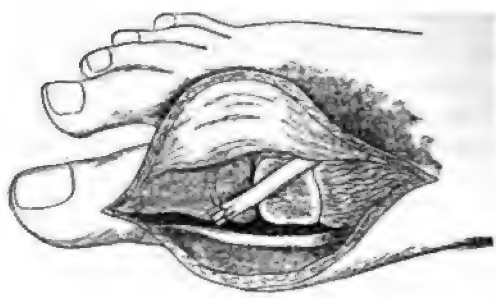


FIG. 1277.—Bunion. Weir's operation. (*Weir.*)

1277), running downwards towards the sole, and encroaching but slight it, and passing backwards and upwards to the middle of the metatarsal b Reflect the flap thus outlined. With a chisel or bone forceps excise sucl tions of bony exostosis as prevent reduction of the deformity. Freely the inner* side of the joint capsule (*i.e.*, the side next to the second toe the sesamoid bones are dislocated outwards, remove them. Divide the

* The words "outer" and "inner" are used in relation to the middle line of the fo not of the body.

tendon near its insertion and suture it to the periosteum at the outer* side of the base of the first phalanx. Close the wound. For two or three weeks keep a pad of gauze between the great and second toes to help hold the replaced toe in position. In the hands of Weir the above operation has given excellent results. Weir remarks: "No operation for the hallux valgus is well done that does not, before suturing, allow the toe to rest easy in its restored position. If any tilting then exists, its cause must be investigated and removed or an imperfect result will ensue."

In the preceding operations any inflamed or enlarged bursa existing over the osseous deformity must be excised.

FIG. 1278.—Bunion. C. H. Mayo's operation. (*Mayo.*)

C. H. Mayo's Operation.—This operation recognizes that excision of the head of the metatarsus is calculated to leave a stiff toe and seeks to avoid this defect. (1) Reflect a flap of skin (Fig. 1278) downwards on the inner side of the metatarso-phalangeal articulation. Do not injure the bursa. (2) Make a flap of the subjacent soft parts with its base at the root of the great toe. Reflect this flap and *with it* the bursa (Fig. 1278). (3) To correct the hallux valgus excise the head of the metatarsus and shave off any bony excrescences. If necessary, excise the articular surface of the proximal phalanx of the great toe (Fig. 1279). (4) Turn the flap containing the bursa into the space between

* The words "outer" and "inner" are used in relation to the middle line of the foot and not of the body.

FIG. 1279.—Bunion. Mayo's operation. (*Mayo.*)

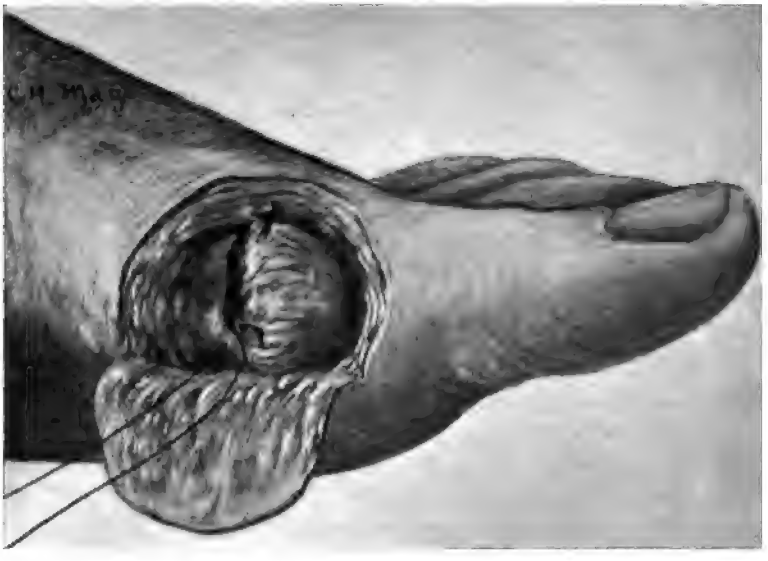


FIG. 1280.—Bunion. Mayo's operation. (*Mayo.*)

the metatarsus and the phalanx and fix it there by a few catgut sutures (Fig. 1280). The bursa having the same structure as a joint takes the place of the excised joint. (5) Pull the dorsal flexor tendon of the great toe inwards so as to lie over the middle of the new joint and fix its *sheath* in this position by a few sutures. (6) Close the external wound. Apply alcohol dressings to the wound and between the first and second toes. The patient may be permitted to walk in a few days. The results are excellent. This appeals to the author as the best operation for bunion. If, when the patient is first seen, the bunion is inflamed, it must be treated until the trouble is quiescent before operation is attempted.

Hammer Toe.—When hammer toe is causing much disability and non-operative measures have failed or seem unsuitable several methods of operating are available.

1. Hoffa strongly recommends Peterson's operation, viz., transverse section of all the soft parts on the plantar side of the toe opposite the first phalango-phalangeal articulation, extension, application of dressings and of a splint. A cure may be expected in 4 or 5 weeks.

2. Excision of the first phalango-phalangeal articulation through a dorsal incision. (The author much prefers a lateral incision even although this makes the operation more difficult.) Enough bone must be removed to permit straightening of the toe without division of the flexor tendon. Albee recommends a plantar incision to one side of the flexor tendon, excision of the offending joint and retention of the toe in a position of hyperextension by means of plaster of Paris.

3. Arthroplasty may take the place of excision, the cut ends of the bone being covered by a flap of fascia lata taken from the thigh or any convenient location.

CHAPTER XCI

OPERATIONS ON THE SCAPULA AND CLAVICLE

Scapula Alata. Deformity in Serratus Paralysis.—When the serratus magnus and the trapezius are paralyzed the scapula becomes very prominent and abduction of the arm impossible.

v. Eiselsberg united the two scapulæ so that they might support each other and thus permit abduction of the arm. When he succeeded in this the shoulders were pulled back so far that the clavicles compressed the vascular and nervous trunks of the arm against the first rib, and to overcome this it was necessary to make an oblique osteotomy of the clavicle.

Duval gave stability to the scapula by uniting it to the sixth and seventh ribs ("Revue de Chir.," 1905, No. 1).

Duval's Operation.—*Step* 1.—Make an incision along the vertebral border of the scapula from the level of its spine down to its angle. Divide the trapezius and rhomboideus major throughout the extent of the wound. Retract the latissimus dorsi strongly downwards (Fig. 1281).

Step 2.—Incise the periosteum along the exposed border of the scapula and reflect it, along with the infraspinatus, from the bone for a distance of about ½ inch (Fig. 1281).

In the same manner separate the periosteum, along with the serratus magnus, from the deep surface of the scapula. *Excise* the periosteum and the serratus magnus to an extent sufficient to permit the denuded undersurface of the scapula to lie freely in contact with the sixth and seventh ribs.

Step 3.—At a distance of 2¾ inches from the middle line denude the sixth and seventh ribs of their periosteum. To give the scapula proper obliquity the denudation of the seventh rib should be about ½ inch further out than that of the sixth.

Step 4.—Unite the scapula to the ribs by two wire sutures as shown in Fig. 1282.

Step 5.—If possible, suture the periosteum over the wires.

Step 6.—Retract the inner edge of the wound (skin, trapezius, rhomboid) and expose the long muscles of the back lying on the posterior surface of the transverse processes in the upper angle of the wound.

Step 7.—From the long muscles of the back make a long and thick flap with its pedicle below. Suture this flap at the superior angle of the scapula to the periosteum and the supraspinatus.

Step 8.—Close the wound without drainage. Apply dressings and a plaster-of-Paris corset for forty-eight days.

Duval has operated three times. His first patient was able to work as a

waiter without trouble. The second patient was improved. The third was not improved.

Mencière ("L'Encéphale," March, 1912; "Lancet," Aug. 17, 1912) modifies Duval's operation. Separate the periosteum from the fifth, sixth and seventh ribs, 9, 10 and 11 cm. respectively, from the middle line, so that the line of attachment of the scapula will be oblique from above downwards and outwards and thus the acromion will be raised. Separation of the periosteum around the ribs permits sutures to surround these bones without pressing on the intercostal nerves. After completing the operation Mencière applies an apparatus which fixes the arm in an elevated position with the hand resting on the top of the head. After 65 days of this, immobilization exercises are instituted.

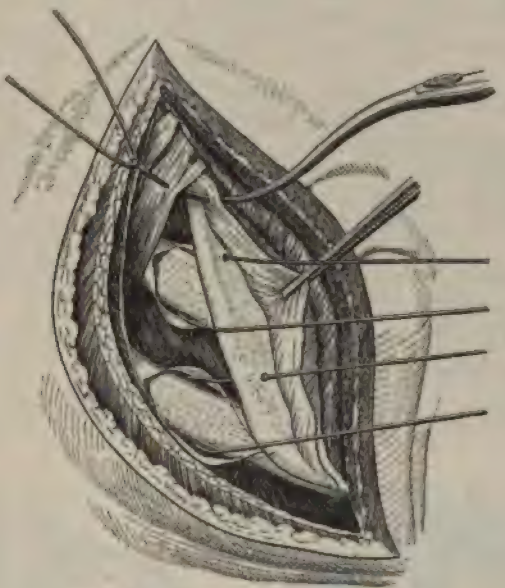


FIG. 1281.—Scapula alata. (*Duval.*)

Transplanatation of Muscle in Serratus Paralysis.—Katzenstein ("Berliner klin. Woch.," 1908, Dec. 28) operated in two stages in the following manner:

Stage I.—*Step* 1.—Make a longitudinal incision near the middle line of the back from the third to the tenth dorsal spines. Expose and divide the portions of the trapezius and rhomboideus major arising from these spines.

Step 2.—Reflect the divided muscles downwards and outwards and suture them snugly to the periosteum of the seventh, eighth, and ninth ribs and to the latissimus dorsi.

Stage II.—*Step* 1.—Make a longitudinal incision along the inner surface of the arm from its middle up, through the axilla to end on the thoracic wall.

Step 2.—Isolate and divide the humeral insertion of the pectoralis major. Free the muscle with its aponeurosis and suture its tendon to the axillary border and to the anterior scapular muscles.

The result was excellent both as regards appearance and function.

Muscle Transplantation in Paralysis of the Trapezius and Serratus Magnus.—In a case of complete paralysis of the *trapezius* due to division of its nerve, Katzenstein ("Berliner klin. Wochsch.," xlvi, No. 49) operated as follows:

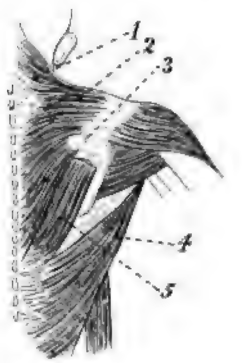


FIG. 1282.—(*Katzenstein.*)
1, 2, 3. Sup. Mid. and Inf. Segments of trapezius. 4. Latissimus dorsi. 5. Flap from lat. dorsi to trapezius.

First Stage.—Through a suitable incision expose the upper margin of the latissimus dorsi and by splitting the muscle, isolate a suitable bunch of its upper fibres; divide this isolated segment of muscle at its humeral insertion thus forming a flap with its pedicle posterior. Suture the free end of the flap to the posterior surface of the scapula below the origin of the triceps. This flap takes the place of the lower fibres of the paralyzed trapezius (Fig. 1282).

Second Stage.—Through a suitable incision expose the upper part of the healthy (opposite) trapezius. Divide its clavicular insertion and carefully preserving its nerve supply form a muscular flap and suture it (Fig. 1283) to the spine of the scapula.

Third Stage.—Form a flap (Fig. 1284) from the middle of the healthy trapezius and suture its free extremity alongside of the flap formed in the second stage of the operation.

The result of Katzenstein's operation was functionally good. In complete paralysis of the serratus magnus and partial paralyses of the inferior fibres of the trapezius Katzenstein devised and carried out the following procedure:

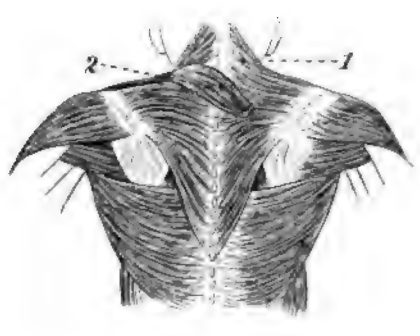


FIG. 1283.—(*Katzenstein.*)
1. Sup. fibres of paralysed trapezius. 2. Flap from healthy trapezius.

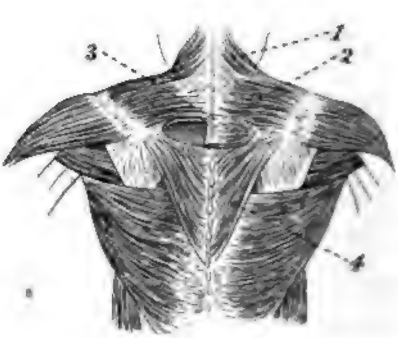


FIG. 1284.—(*Katzenstein.*)
1, 2, 4. Sup. Med. and inferior segments of trapezius. 3. Flap transplanted from left to reinforce right trapezius.

1. Division of the spinal origin of the rhomboid muscles and transplantation of their origin to lower vertebræ thus reversing the action of the muscles and making them assistants to instead of antagonists of the serratus magnus.

2. Division of the tendon of the pectoralis major at the level of the humerus

and suture of it to the axillary border of the scapula so as to correct the *scapula alatum* which was present. The result was excellent.

Paralysis of Trapezius Muscle.—Treatment by "free" transplantation of fascia. *Rothschild's operation.* When the upper arm is raised above the horizontal this motion is due to the serratus magnus while the trapezius keeps the scapula sufficiently fixed so that the serratus is able to act with power. If the trapezius is paralyzed it becomes impossible to raise the arm unless the scapula is held in place by some artificial means. Rothschild accomplishes the fixation of the scapula in the following manner. ("Zeit. für Chir.," Nov. 5, 1910.)

Step 1.—Make an oblique incision from the upper and inner angle of the scapula, downwards to the first lumbar vertebra. Expose the vertebral border of the scapula, part of the paralyzed trapezius, part of the latissimus dorsi.

Step 2.—From the thigh excise a strip of fascia lata about 8 inches long and 1¾ inches wide.

Step 3.—Suture one end of the strip of fascia securely to the supraspinatus and its fascia. Suture the other end of the strip to the latissimus dorsi and deep muscles near the spine. Before suturing the vertebral end of the strip of fascia put so much tension on it that the scapula is pulled up to the level of its fellow on the opposite side and its vertebral border is parallel to the spine. In order to prevent adhesion between the fascial implant and the skin, Rothschild recommends that a small opening be made through the paralyzed trapezius near the scapula and that the flap be passed through this opening and conducted under the trapezius to the site of its suture to the trapezius. Rothschild has found this operation completely satisfactory.

Deltoid Paralysis.—Transplantation of Trapezius.—Dean Lewis' operation. ("Journ. A. M. A.," Dec. 24, 1910.)

Step 1.—Make a longitudinal incision from the middle of the outer border of the trapezius to the junction of the middle and lower thirds of the deltoid.

Step 2.—Divide the clavicular, acromial and part of the spinous attachments of the trapezius.

Step 3.—Separate the atrophied deltoid from the clavicle and spine of the scapula and turn it down.

Step 4.—Open the sheath of the long head of the biceps, lift up the tendon and plicate it (Kiliani) so as to correct the subluxation.

Step 5.—Suture the trapezius to the articular capsule where it is attached to the humerus.

Step 6.—Turn the flap of deltoid upwards over the trapezius and suture it high up while the arm is abducted.

Step 7.—Suture the upper part of the skin wound in such a manner as to make the cicatrix at right angles to the original direction of the wound. This helps to overcome the subluxation. Close the rest of the wound. The resulting scar is **T**-shaped, the horizontal arm of the **T** extending across the summit of the shoulders.

Step 8.—Apply dressings. Immobilize at an angle of about 100°. After about four or five weeks gradually lower the arm.

Excision of the Scapula.—Indication.—Malignant neoplasms of the scapula constitute the indication for its complete removal. As a rule, as much as possible of the muscles attached to the bone should be removed along with it, since sarcoma is liable to spread from the bone along the muscles (see remarks on tumors of bone). If skin is involved, the incisions must be so planned as to surround the affected areas.

Potel in a case of spindle-cell sarcoma which involved almost all the scapula and the attached muscles excised the scapula but preserved the glenoid fossa thus keeping the shoulder-joint intact. Two and one-half years later the patient was well and had good function. Quénu in discussing Potel's report advised preservation of the glenoid fossa, but if this is impossible he advised fixation of the head of the humerus to the outer end of the clavicle (International Abstracts, Aug., 1914).

If the humerus or axilla are involved, the question of inter-scapulo-thoracic amputation at once arises. If the scapula is fixed to the chest wall, operation is usually contraindicated as the thorax is invaded.

Step 1.—Place the patient on his back. Abduct the arm. From the apex of the axilla make a 3-inch incision down the arm, immediately behind the anterior wall of the axilla, along the inner and posterior border of the coraco-brachialis. Raise the anterior fold of the axilla and expose the coracoid process. With blunt-pointed scissors cut the three muscles attached to the coracoid close to the bone. This fully exposes the axillary artery. The subscapular artery "arises opposite the lower border of the subscapularis and runs downwards and inwards along the anterior border of that muscle under cover of the latissimus dorsi. * * * It is accompanied by two veins. * * * About 2.5 or 3.7 cm. (1 or 1½ inches) from its origin, the subscapular artery divides into two end branches: (1) the circumflex (dorsal) scapular, and (2) the dorsal thoracic" (Morris) (Fig. 1285). Recognize and ligate the subscapular artery. This step (Cheyne, Jacobson) saves much trouble from bleeding and the separation of the muscles attached to the coracoid greatly simplifies the later stages of the operation. The truth of these observations was agreeably impressed on the author in a case of gigantic enchondroma in which he was associated with Dr. Sudler.

Step 2.—Pack the axillary wound. Turn the patient on to his sound side and bring his back close to the edge of the table.

Incision A.—Make "a T-shaped incision, one limb running from the acromio-clavicular joint inwards to the superior angle of the scapula, while the other and longer is made at right angles to the first down to the angle of the scapula."

Incision B.—Make a ⊢⊣-shaped incision, one cut running along the vertebral border of the scapula, the other at right angles to it across the centre of the growth.

Incision C.—Same as B except that the horizontal cut runs on the spine of the scapula and reaches to the acromio-clavicular joint or if a portion of the acromion is to be preserved, to the top of the acromion.

Step 3.—Incision C has been adopted. Reflect the two skin flaps formed

by the ⊢⊣-shaped cut. Examine the deltoid and trapezius muscles. If their condition is above suspicion, preserve them; if not, those portions which are attached to the scapula must be excised. Pass the finger under the deltoid and hook up the muscle. If the muscle is to be preserved divide its origin at the spine of the scapula and reflect the muscle outwards; if it is to be removed

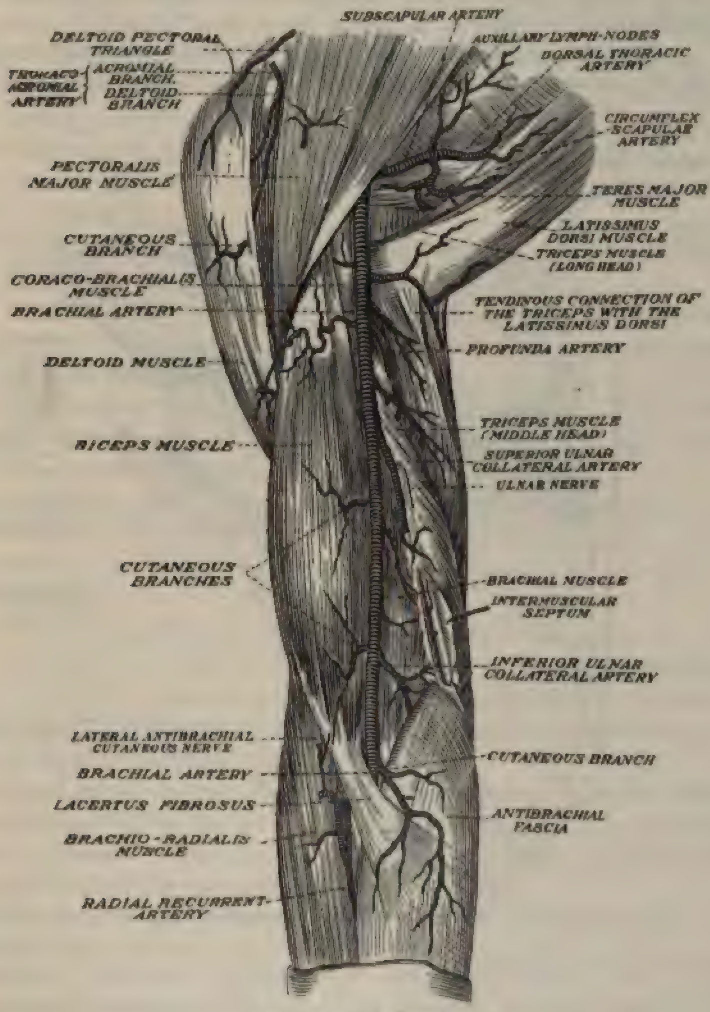


FIG. 1285.—(*Morris.*)

split the muscle along the junction of its scapular and clavicular portions. Follow the scapular portion down to its insertion in the humerus and there divide it, leaving the muscle hanging attached to the scapula. The clavicular portion of the deltoid is left intact.

Step 4.—Expose and divide the following tendons which are inserted into or near the upper end of the humerus—subscapularis, the long head of the

biceps, supra-spinatus, infra-spinatus, teres minor and major. The capsule of the shoulder-joint is of course opened. In the upper and outer part of the wound under the head of the humerus, lies the long head of the triceps; isolate and divide this carefully, avoiding injury to the circumflex nerve going to the deltoid. If part of the acromion process is to be preserved, divide it at the desired spot; if not, separate the soft structures from it and freely open the acromio-clavicular articulation.

Step 5.—Pass the finger under the trapezius muscle and treat it exactly as the deltoid was treated, *i.e.*, either divide it at its insertion along the upper edge

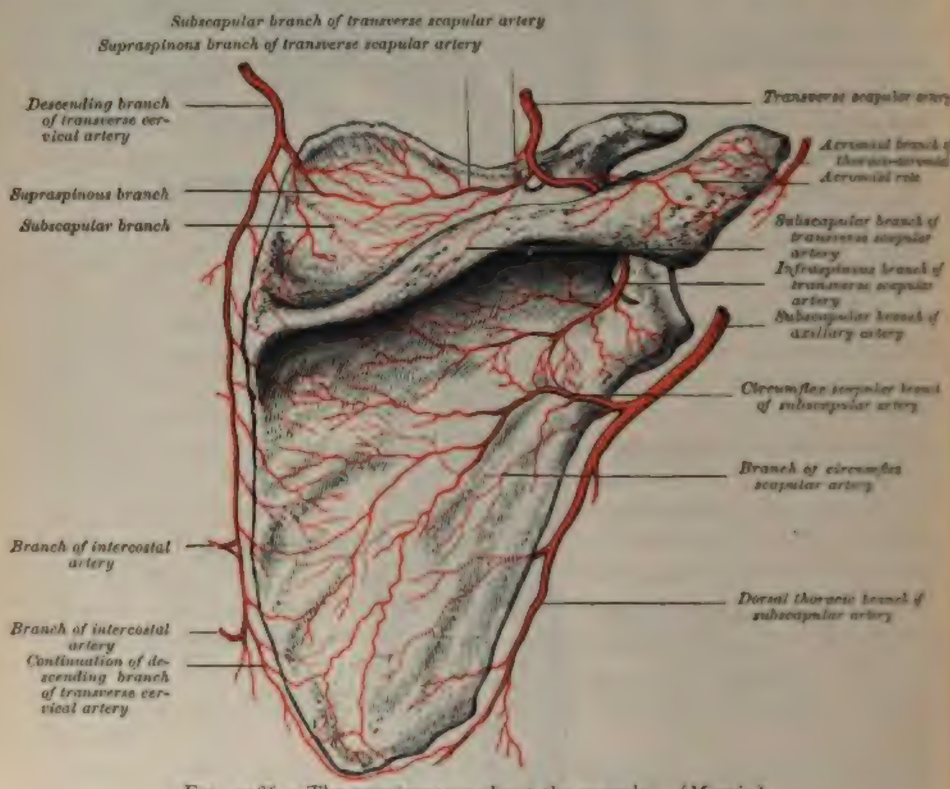


FIG. 1286.—The anastomoses about the scapula. (*Morris.*)

of the spine of the scapula and reflect it upwards, or separate (by splitting) its clavicular from its scapular portions and, separating the latter from the chest-wall, divide it as near its origin as possible, leaving the muscle to be removed attached to the scapula.

Step 6.—At the upper border of the neck of the bone detach the omo-hyoid. Ligate and divide the supra-scapular (transverse scap.) artery (Fig. 1286). Divide the levator anguli scapulæ at the upper angle of the bone and ligate and divide the posterior scapular (descending branch transverse cervical) artery. Divide the rhomboids and the serratus magnus.

Step 7.—Complete the division of the capsule of the shoulder-joint. The st step in the operation has attended to the freeing of the coracoid process and ;ation of the subscapular artery. Remove the scapula.

Step 8.—Attend to hemostasis. Quénu unites the antero-inferior part of e capsule to the soft parts under the clavicle. With a wire suture he unites e upper part of the capsule to the scapula through which a hole is bored to re- ive the wire. The long head of the biceps is sutured in the same fashion to e clavicle. (If the scapular portion of the deltoid has been preserved, suture lower part, if possible, to the rhomboid; its upper part to the trapezius.) ose the wound providing freely for drainage.

"The results are excellent; the patient retains all movements of the limb, th the exception that he is unable to abduct the arm above a right angle from e trunk" (Burghard).

Subperiosteal Excision Scapula (Ollier).—Indication for operation is ually osteomyelitis with its complications and sequelæ.

Step 1.—Make an incision down to the bone along the spine of the scapula om the acromion to the vertebral border. With knife and elevator separate e trapezius from the scapular spine.

Step 2.—Make an incision along and expose the whole vertebral border of e scapula. Through this, subperiosteally, separate the soft parts from the me both above and below the scapular spine.

Step 3.—Pull the vertebral edge of the scapula away from the chest and sub- riosteally separate the subscapularis and all other soft structures from the terior surface of the scapula—until the axillary border and the neck of the one are reached.

Step 4.—Divide the acromio-clavicular joint from below upwards. Divide e articular capsule and the tendinous insertions on the upper end of the umerus. Divide the base of the coracoid process. Unless it is absolutely ecessary to remove the head of the scapula it is better to divide the neck of he bone and leave the articulating surface intact.

Subperiosteal resection when indicated is a much easier operation than the ame procedure carried out on the normal cadaver because disease thickens the eriosteum and loosens it from the bone. After subperiosteal excision the bone s often almost completely regenerated.

Partial Excision of the Scapula.—Almost any portion of the scapula may e excised through suitable incisions, and such operations require no special escription.

Excision of the Clavicle.—Subperiosteal resection of the clavicle may be emanded in the treatment of necrosis.

Step 1.—Make a cut along the clavicle from the acromion process to the ernum. Divide the periosteum.

Step 2.—With an elevator separate the periosteum from the front surface of e bone. With a curved elevator (many elevators are provided with a point ich while blunted i[illegible] enough to do damage if a slip occurs, the f of the best elevat[illegible] less square with rounded angles) hugging

the bone separate the periosteum from the posterior surface of the bone near its middle.

Step 3.—(*a*) With Gigli's saw or bone forceps divide the bone near its middle. Grasp the end of the inner fragment with strong forceps and pull it forwards. It is now easy to separate the fragment from the surrounding soft parts by blunt dissection aided by an occasional snip of the scissors (the scissors must be made to cut *against* the bone) and so to remove the whole inner end of the bone. It is always best if possible to divide the bone near its sternal articulation and to leave the articular end of the bone *in situ*. Do the same to the outer end of the bone. The insertion of the subclavius at the junction of the outer and middle thirds of the bone requires sharp division (always cutting on the bone). The coraco- and acromio-clavicular ligaments require division with knife or scissors, if the outer extremity of the bone is to be sacrificed, but it is always best to save the acromio-clavicular joint if possible.

(*b*) Instead of dividing the clavicle at its middle, divide it near its outer end or open the acromio-clavicular joint. Seize the outer mobilized end of the bone and pull it forwards. Separate the bone from the soft parts subperiosteally and remove it entire or in part.

Step 3.—Cleanse and close the wound, providing for very free drainage which is necessary because the operation is generally performed for necrosis.

Treat as a fractured clavicle.

Excision of Clavicle for Sarcoma.—*Step* 1.—Make an incision through the skin alone along the whole length of the bone. Supplement this cut by vertical ones, if required for the reflection of the skin from over the whole of the tissues to be removed.

Step 2.—Expose the outer edge of the clavicular insertion of the sterno-mastoid. Pass a finger or director (the author for such purposes used a closed blunt-pointed scissors curved on the flat) behind the clavicular portion of the muscle and divide it at a safe distance from the disease. Expose the inner edge of the clavicular insertion of the trapezius and divide it in the same manner. In the same fashion divide such portions of the pectoralis major and the deltoid as are attached to the clavicle.

Step 3.—Mobilize the acromial end of the bone by dividing the acromio- and coraco-clavicular ligaments. This is a difficult step (Fig. 1287). Pull the outer end of the clavicle forwards. Remember the subclavian vein which is separated from the bone by the subclavius muscle. Separate the bone and tumor up to the claviculo-sternal articulation. Disarticulate.

Step 4.—Attend to hemostasis. Close the wound. Dress. Treat like a fracture of clavicle.

The results as regards use of the arm, strange to say, are reported to be most excellent.

Excision of the Clavicle with Repair by Bone Transplantation.—After excising the clavicle in whole or in part the defect may be repaired by transplanting a suitable segment of bone, preferably from the patient himself. Bone may be obtained easily from the tibia. Witzel (Molineus, Deutsche Zeitsch. f. Chir.,

cxxi, 180) in two cases excised the outer two-thirds or more of the clavicle and filled the osseous defect by transplantating the spine of the scapula. The spine of the scapula and the clavicle were exposed by an incision beginning one hand's breadth from the vertebral column and running outwards along the spine of the scapula to be continued anteriorly two fingers' breadths below the parallel to the clavicle. The epaulet like flap outlined by the incision was reflected upwards, the clavicular insertions of the pectoralis major and deltoid were divided, the acromio-clavicular joint opened and the diseased portion of clavicle removed.

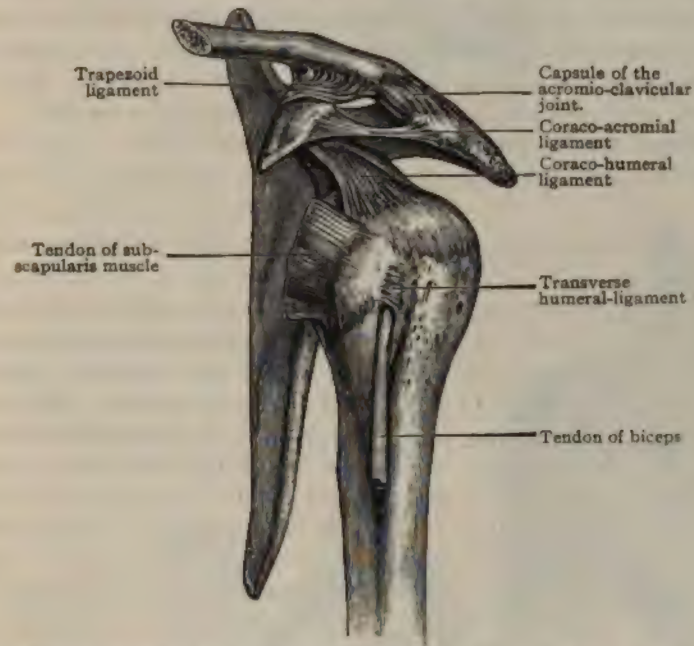


FIG. 1287.—Outer view of the shoulder-joint, showing the coraco-humeral and transverse humeral ligaments. (*Morris.*)

After separating the supra- and infra-spinati from the scapular spine, the latter was cut away from the scapula with a chisel. (At the median or vertebral end it may be necessary to remove a portion of the body of the scapula along with its spine). It was now easy to swing the mobilized bone forwards and to unite it with the stump of clavicle by a wire suture. After 4 weeks, passive motion was begun and in 8 weeks there was almost perfect function.

Presternal Dislocation of the Clavicle.—Grunert ("Med. Klinik," May 29, 1910) recommends, in presternal dislocation of the clavicle, that the meniscus of the sterno-clavicular joint be excised and the bones united by three sutures.

CHAPTER XCII

SHOULDER

Intra-articular injections for the introduction of iodoform emulsion or Murphy's formalin glycerine. Introduce the trocar either just external to the coracoid process or external to the angle of the acromion (*i.e.*, the angle formed by the junction of the scapular spine and the acromion process). Push the trocar into the prominence formed by the swelling of the joint capsule.

Arthrotomy for Drainage.—It is usually recommended to open the joint by an anterior vertical incision as in arthrectomy but drainage through such a cut is not efficient and a counter opening is usually required. The following operation is entirely preferable:

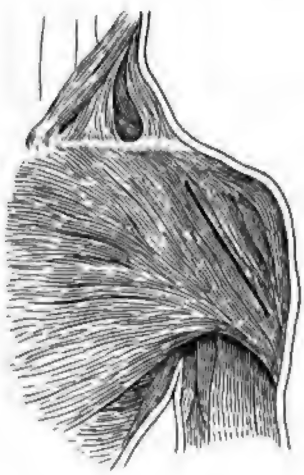


FIG. 1288.—Arthrotomy.

Beginning at the posterior prominence or angle of the acromion process make an incision downwards along the posterior border of the deltoid for about 2 inches. This opens the subdeltoid bursa. Retract the edges of the wound and expose the joint capsule crossed by the tendons of the infra-spinatus and teres minor. Incise the capsule. Explore the joint lest resection should be demanded. Drain.

Ollier's Operation or Subperiosteal Resection.—*Step* 1.—Abduct the arm moderately and have an assistant hold it steadily. From a point ½ inch below the clavicle and beside the coracoid process make an incision 4½ to 5 inches in length, which is directed downwards and outwards towards the insertion of the deltoid (Fig. 1288). The incision divides the skin and subcutaneous tissues. Distinguish the anterior or internal (pectoro-deltoid groove) border of the deltoid. Incise the deltoid a little to the outside of, and parallel to its internal margin, thus avoiding injury to the cephalic vein and a large branch of the acromio-thoracic artery. Retract the outer side of the wound (skin and deltoid), thus exposing the head of the humerus.

Step 2.—Rotate the arms so as to make out the bicipital groove. Incise the joint capsule throughout its whole extent parallel and external to the tendon of the biceps. Do *not* injure the acromio-coracoid ligament. Prolong the capsular incision downwards on the humerus, dividing the periosteum, to the point where it is desired to sever the bone (Fig. 1289). Introduce a sharp but not pointed periosteal elevator and separate the periosteum

insertions, on the outer side of the wound, from the external or greater tuberosity. As the separation progresses the assistant rotates the humerus inwards. In using the sharp elevator keep the edge of the instrument firmly pressed against the bone, and when there is danger of tearing the periosteum endeavor to sacrifice bone rather than impair the integrity of its fibrous covering. If these rules are observed, the tendinous insertions and periosteum will be raised from the bone

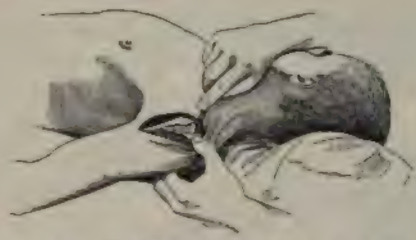


FIG. 1289.—Excision of shoulder. (*Schwartz.*)

together and remain attached to the fibrous capsule of the joint. One is rarely completely successful in this, but even partial success is beneficial. The external tuberosity having been denuded, open the sheath of the biceps tendon, lift the tendon from its groove and retract it inwards. Separate the periosteum and tendinous insertions from the internal or lesser tuberosity in the manner already described, while doing so have the assistant rotate the arm outwards. Make the head of the humerus protrude into the wound by carrying the elbow

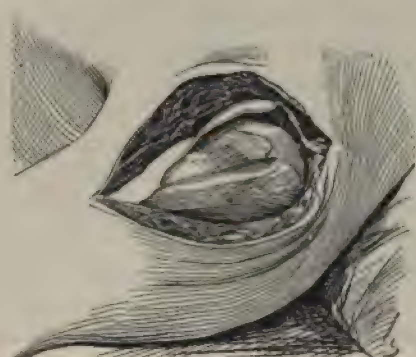


FIG. 1290.—Excision of shoulder. (*Schwartz.*)

backwards and upwards. Separate the posterior and lateral fibrous attachments from the bone by the method already described (Fig. 1290).

Step 3.—Examine the head of the bone and make it protrude out of the wound (Fig. 1291). Saw off as much of the upper end of the humerus as is rendered necessary by the presence of disease.

Step 4.—Examine the glenoid cavity and if disease is present remove it with a sharp spoon, chisel, or ronguer forceps.

Step 5.—With forceps and scissors dissect away all diseased synovialis. The walls of all sinuses must be removed by dissection or by curettement.

Step 6.—Provide for posterior tubular drainage by an incision in an appropriate position behind. Rub the wound with iodoform. Provide for drainage of anterior wound and partially close it with sutures. Apply dressings. A large pad must be placed in the axilla to keep the upper end of the humerus from falling inwards and the elbow and forearm bandaged to the chest. As soon as the wound has healed, the tone of the shoulder muscles may be kept up by applications of electricity. No passive movements or massage must be attempted before the lapse of about eight weeks and the movements of abduction must be the last to be used. The reason for delaying movement is that one must wait until the upper end of the humerus has become to some extent fixed in its new position and thus avoid an undesirable "flail-joint."

FIG. 1291.—Excision of shoulder. (*Schwartz.*)

In some cases where the tissues have not been softened by inflammation it is very difficult to detach the periosteum and tendinous insertions from the major and minor tuberosities of the humerus. After this feat has been attempted the detached periosteum is usually a thing of "shred and patches." In the case of the hip- and ankle-joints König has overcome this difficulty by chiseling off from the main bone a shell of bone and retracting it along with its periosteal and tendinous attachments. The method has many good features in addition to its simplicity that the author has applied to the shoulder-joint.

Expose the shoulder through the Ollier incision. Divide the periosteum of the humerus along the outer edge of the bicipital groove. Place a chisel in position with its edge against the outer margin of the bicipital groove and cut through the great tuberosity (Fig. 1292). Reflect the detached shell of bone with all its connections outwards. Lift the long tendon of the biceps outwards. With the chisel cut the lesser tuberosity free from the shaft of the humerus. Reflect inwards the shell of bone, with its periosteal connections and with the long head of the biceps. Dislocate the head of the humerus into the wound, at the same time severing its posterior attachments with periosteal elevator or scissors as already described.

After the active operation is completed, examine the shells of bone which remain attached to the periosteum. If they show evidences of disease, remove them; if not, replace them. When the shells of bone are replaced, arrange them

in such a manner that the long tendon of the biceps will remain superficial to them.

W. T. Reynolds' Method.—From a point a short distance below the coracoid process make an incision downwards and slightly outwards until the lower edge of the anterior axillary fold is divided and the pectoralis major is exposed. Divide the pectoralis major at right angles to its fibres and about 1½ inches

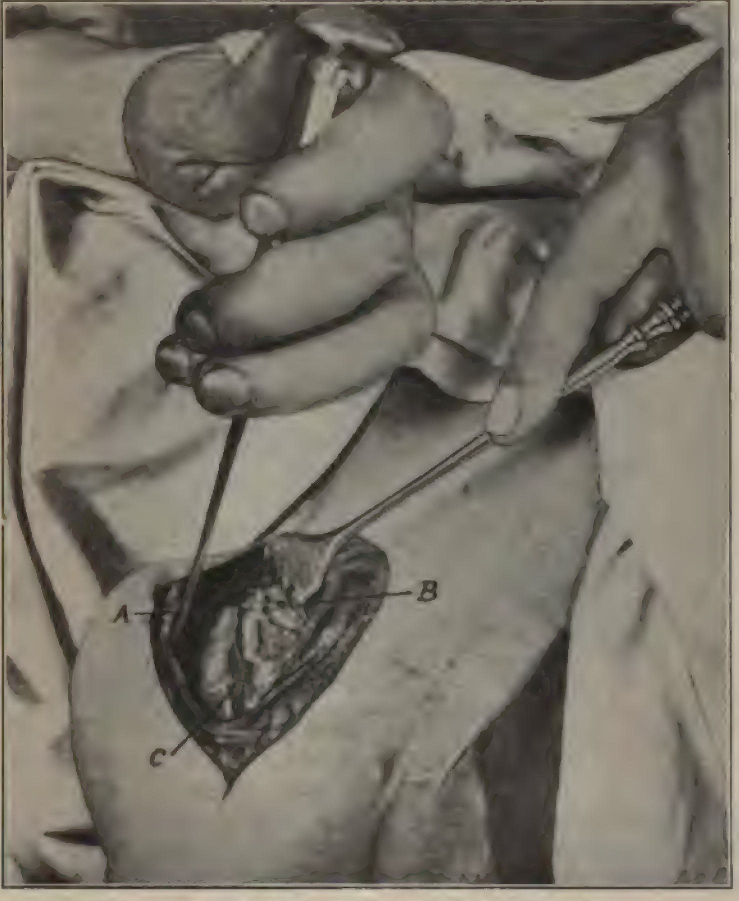


FIG. 1292.—Author's method of excision of shoulder
A. External shell of bone (major tuberosity held outwards by chisel); B. Internal shell of bone retracted inwards; C. Bicipital groove.

from its insertion. This gives excellent access to the shoulder joint. After completing whatever procedures are required on the bones or joint, suture the divided muscle carefully and close the wound. Good function of the shoulder may be expected.

Atypical Resection of the Shoulder.—In children it is especially desirable to avoid typical resection of the upper end of the humerus, because injury to or destruction of the epiphyseal cartilage leads to non-development of the upper

arm. In suitable cases one can expose the joint by the Ollier method, e the head of the humerus and the glenoid cavity and with chisel and sharj remove any osteal foci of disease which may be found. The principles o ment are the same as in the case of the knee-joint.

Resection of the Shoulder from Behind (Kocher).—When the ; cavity is much diseased or the arthritis is very diffuse, the usual anterior do not give sufficiently free access to the joint. For these cases Koch devised the following operation:

Step 1.—Beginning at the acromio-clavicular joint, make an incision the upper margin of the spine of the scapula to about the middle of that from this point continue the incision in a curve downwards and outwa about two fingers' breadth from the posterior axillary fold (Fig. 1293).

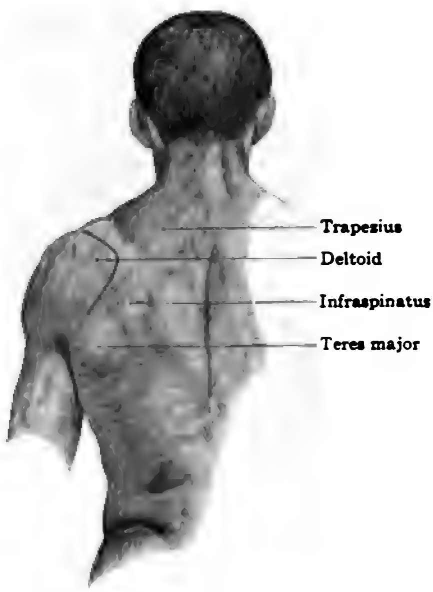


FIG. 1293.—Kocher's incision. (*Kocher.*)

Step 2.—Open the acromio-clavicular joint. Divide the insertion trapezius into the spine of the scapula throughout the length of the v Expose the posterior margin of the deltoid, push the finger under the (and separate it from the underlying infra-spinatus. Divide a portion origin of the deltoid posteriorly (Fig. 1294). Push the finger along the surface of the spine of the scapula, between the deltoid and the infra-sj to the place where the infra-spinatus loses touch with the spine. Bluntl the supra-spinatus away from the upper surface of the spine until the fin be hooked round the outer end of the spine.

Step 3.—**Method A.**—With a chisel make an oblique section of the s the scapula, so that the acromion process and the whole crest of the sc spine from which the deltoid arises are separated from the body of the

Before dividing the bone it may be well to drill holes in the bone on each side of the line of section so as to be able conveniently to wire the fragments on completion of the operation. Instead of boring holes, one may subperiosteally resect a small fragment of bone on each side of the line of section, thus leaving small flaps or tags of periosteum which may be sutured together. In dividing the bone be careful not to injure the supra-scapular nerve as it goes through the great scapular notch.

Method B.—Instead of cutting off the mass of the spine of the scapula, merely cut off, subcortically, that portion from which the deltoid arises.

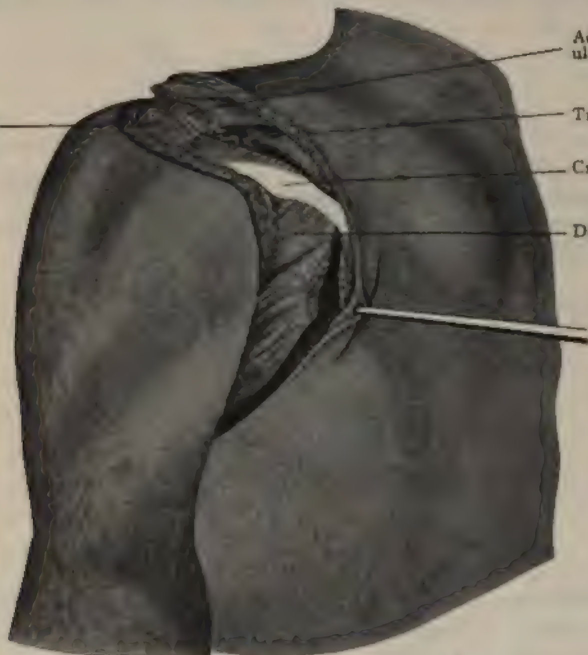


FIG. 1294.—Kocher's incision. (*Kocher*.)

Step 4.—Turn downwards the flap of deltoid muscle with its bony attachments (Fig. 1295). This exposes very freely the outer and posterior surfaces of the head of the humerus with the attachments. Rotate the arm outwards. Make a longitudinal incision down to the bone along the posterior margin of the bicipital groove and expose the biceps tendon up to its origin above the glenoid cavity.

Step 5.—Beginning at the posterior margin of the bicipital groove, separate the periosteum, and with it the external rotators of the humerus from the greater tuberosity, and retract these structures backwards. Inspect the biceps tendon and its sheath. Retract the tendon forwards. By flexing the elbow, rotating the shoulder, pushing the head through the wound, etc., etc., it is now possible to inspect the whole joint and judge if it is necessary to resect the joint or if a mere arthrotomy will suffice.

If arthrectomy is necessary proceed to

Step 6.—Subperiosteally separate the insertions of the muscle from the lesser tuberosity forwards and inwards. Complete the resection, removing all diseased tissue.

Step 7.—Replace the deltoid flap and fix it in position by sutures. Provide drainage. Dress.

Kocher's operation sounds formidable, but innervation is well preserved and the after-results are remarkably good. If partial resection is sufficient Kocher's method permits the anterior part of the capsule, the subscapular muscle and the coraco-humeral ligament to remain uninjured, thus avoiding subsequent dislocation.

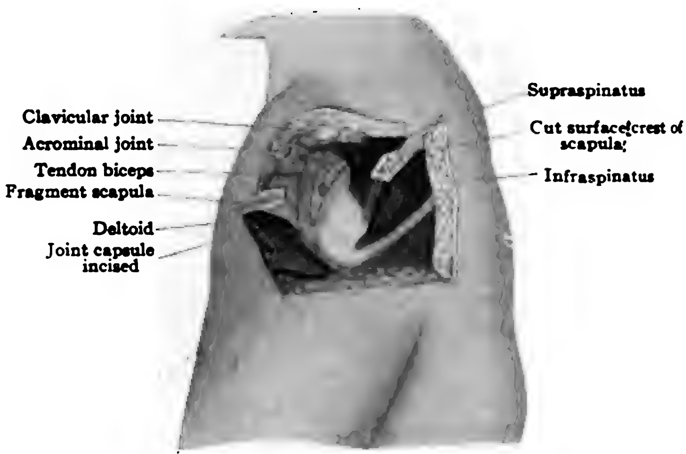


FIG. 1295.—Kocher's operation. (*Kocher.*)

Excision Shoulder.—A rational method of resection must comply with the following conditions: Catterina ("Zentralblatt für Chir," 1906, No. 2).

1. It must be safe and must hazard no important structures.
2. It must be easy.
3. It must afford a good view of all parts of the joint cavity.
4. It must be suitable to all cases requiring resection.

Catterina endeavors to fulfil these requirements by temporary resection of the outer third of the clavicle, thus obtaining free exposure of the joint and avoiding injury to the deltoid and to the circumflex nerve. The method is suitable to all cases, especially to those of old anterior dislocations requiring reduction or excision.

Step 1.—From a point about 2 inches above the junction of the middle and outer thirds of the clavicle make an incision downwards and outwards through the skin and fascia for about 6 inches along the groove between the pectoralis major and the deltoid. Retract, or doubly ligate and divide, the cephalic vein.

Step 2.—At the junction of its middle and outer thirds separate the soft parts from the clavicle sufficiently to bore two holes through the bone about

ıpart. Midway between these two holes (which will serve for future. livide the bone with a Gigli wire saw.

3.—Rotate the external portion of the clavicle outwards and divide its ›ns with the trapezius, the subclavius, and the coraco-clavicular liga- ,eave the clavicular origin of the deltoid intact (Fig. 1296).

ı.—Reflect the flap consisting of bone, deltoid, etc., outwards and back- as to expose the joint fully.

;.—Treat the joint *secundum artem.*

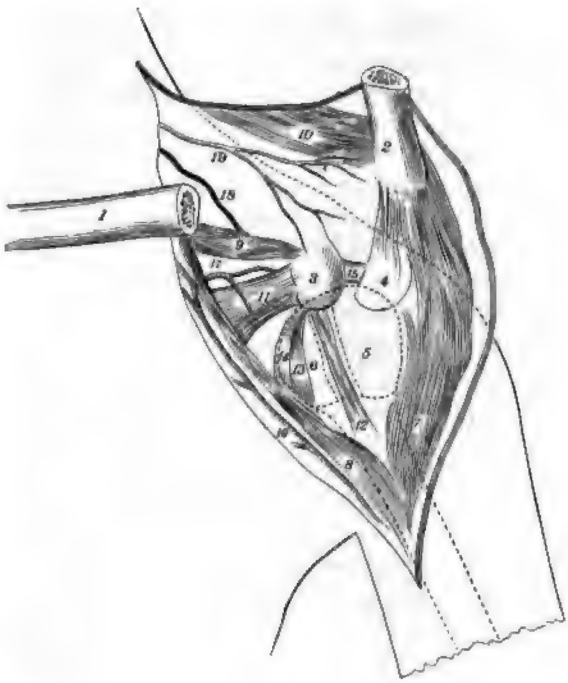


FIG. 1296.—Catterina's operation. (*Catterina.*)

cle. 2. External third clavicle. 3. Coracoid. 4. Acromion. 5. Great tuberosity humerus :uberosity humerus. 7. Clav. portion deltoid. 8. Pectoralis major. 9. Subclavius 10. 11. Pectoralis minor. 12. Long head biceps. 13. Short head biceps. 14. Coraco-brachialis. -acromial ligament. 16, Cephalic vein. 17. Thoracico-acrom. art. 18. Suprascap. nerve. :ap. art.

6.—Replace the flap. Wire the clavicle. Close the wound after pro- ›r drainage.

ıead of the scapula is diseased or injured, the head of the humerus is d. Resection is required. v. Esmarch operates as follows:

ıke a curved incision around the posterior margin of the acromion e the fibres of the deltoid there inserted (Fig. 1297). Expose the poste- ıpper surface of the joint capsule.

ın the middle of the incision cut with a knife down to the postero- ıargin in the head of the scapula, make a longitudinal incision through capsule between the tendons of the supra- and infra-spinatus to the

middle of the greater tuberosity. This cut divides the skin and the deltoid (in the direction of its fibres).

3. Retract the soft parts. With a periosteal elevator separate the long head of the biceps, the articular capsule and the periosteum all together from the neck of the scapula. With a finger saw divide the neck of the scapula and remove the glenoid cavity.

4. Close the wound after providing drainage.

When a shoulder dislocation has remained unreduced for even a comparatively short time, the head of the humerus becomes adherent to its surroundings. In subcoracoid and subglenoid dislocations the vessels and nerves are stretched directly over the head of the bone, and as they are liable to become adherent to the bone it is easy to see how dangerous vigorous efforts at manual reduction may become. This constitutes the main *danger* in manipulative reduction, the main *difficulties* arise (*a*) from the adhesions; (*b*) shortening of the muscles and tendons inserted in the tuberosities; (*c*) contractions and alterations of the capsule which may fill up the glenoid cavity; (*d*) changes in the glenoid cavity due to chipping of its border and such like lesions; (*e*) in a case operated on by Tully Vaughan bony material was found occupying the glenoid cavity. This bony material consisted of a detached greater tuberosity which was adherent to the margins of the glenoid cavity, the floor of which was smooth and unchanged.

FIG. 1297.—Esmarch's incision. (*Esmarch.*)

Cheyne and Burghard lay down the rule that it is not advisable to attempt the reduction of a subcoracoid or subglenoid dislocation after four or five weeks have elapsed from the time of injury, and that it is practically unjustifiable to attempt it after seven weeks. Even within the period mentioned any attempts at reduction must be made with extreme care, as rupture of the axillary artery has resulted from attempts to reduce a dislocation of four weeks' standing.

Operations for reducing (so-called irreducible) dislocations of the shoulder may be roughly classified as follows:

I. Subcutaneous myotomy or tenotomy.
II. Osteotomy.
III. Arthrotomy or arthrotomy plus resection.
IV. Capsulorrhaphy (with or without arthrotomy).
V. Athrodesis.

Subcutaneous Myotomy and Tenotomy.—The few cases of reduction after the subcutaneous division of obstructing bands seem to have been uniformly successful. [Unsuccessful operations have probably escaped publication.]

Weinhold (1818) divided the pectoralis major; Dieffenbach divided the pectoralis major, latissimus dorsi, teres major and minor, and even some of the ligaments; Simon obtained recovery after seventy successive operations on

one patient. Polaillon operates as follows: Introduce a sharp-pointed tenotome horizontally from without inwards to the head of the humerus at a point one centimeter below the tip of the acromion. Guided by this instrument introduce a long probe-pointed tenotome until it penetrates between the anterior surface of the head of the humerus and the deltoid. Remove the sharp-pointed instrument. Cutting against the bone divide all obstructing fibrous tissues. Partially withdraw the tenotome; reintroduce it behind the head of the humerus and with the same precautions divide all obstructing fibrous bands there situated. In similar fashion divide obstructing bands in any position around the upper end of the humerus. Delay efforts at reduction for a few days until the tenotomy wound has healed. Mollière operates very similarly, but proceeds to manipulative reduction as soon as the tenotome is removed. Forgue and Reclus recommend subcutaneous operation because of its ease and safety. Cahier considers that the operation possesses all the disadvantages of work done in the dark, viz., dangers to nerves, vessels, and to the long head of the biceps, that it only incompletely divides obstructing bands and that it pays no attention to the fragments of bone torn from the greater tuberosity (when that is fractured) and remaining attached to various tendons. Most surgeons will agree with Cahier in these conclusions.

Osteotomy of Humerus for Irreducible Dislocation.—In one case J. Ewings Mears performed subcutaneous osteotomy for old subcoracoid dislocation. At first the result was good, later callus, etc., impaired the usefulness of the limb. In cases where there are no serious pressure symptoms and owing to age, debility, etc., the patient is unsuited to a long operation, Souchon proposes to resect one inch of the shaft of the humerus where it joins the head and place the resected extremity in or near the glenoid cavity. This leaves the head in abnormal position, but, as already noticed, the head is causing no serious pressure symptoms and the patient is unfit for more serious interference.

Arthrotomy for Unreduced Subglenoid or Subcoracoid Dislocation of the Shoulder.

1. Open the joint by Ollier's anterior incision.

2. Retract the deltoid outwards, the pectoralis major inwards. This exposes the head of the bone.

3. Examine the position of the vessels and nerves; note if they adhere to the bone; avoid injuring these structures. Examine the anatomical neck of the bone; divide the fibrous structures adherent to it, with a periosteal elevator detach them from the head and neck of the bone; keep the instrument *against* the bone during this work so as not to injure the vessels and nerves.

4. Apply extension to the arm. With the finger feel for bands obstructing reduction; divide such.

5. Examine the glenoid cavity. If it is filled with fibrous tissue, clear such away by dissection. If the capsule is in fair condition, preserve it; if it hinders reduction, divide it, and after reduction repair it by sutures. If the capsule is in bad condition, *i.e.*, contracted and distorted, dissect it away.

6. Try to reduce the dislocation. This is usually possible. If, however,

reduction is still impossible examine with the finger for the obstruction. The obstruction is commonly muscular (supra and infraspinatus). Very gradually separate these muscles at their insertion into the great tuberosity. Do not separate them one iota more than is necessary for reduction. Separation of the subscapularis from the lesser tuberosity is to be avoided if possible. Complete the reduction.

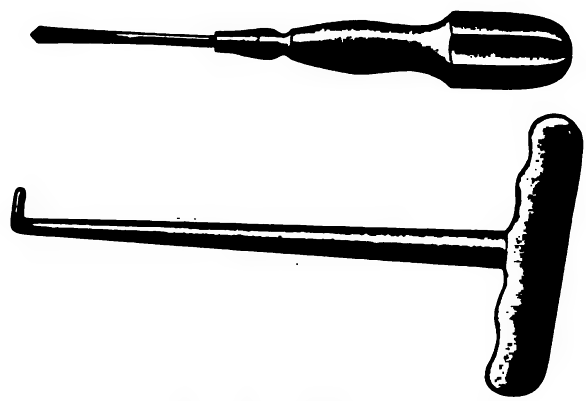


FIG. 1298. (*McBurney.*)

7. If sufficient capsule remains, repair it by sutures. With sutures restore the soft parts, both deep and superficial, as nearly as possible to their normal condition. Close the wound with or without drainage. Dress. Keep the arm bound to the side until healing is complete. Begin passive motion early, using an anesthetic if necessary.

The operation is more complex when there is fracture of the neck of the bone as well as dislocation of the head. If the head of the bone is seemingly sufficiently nourished reduction must be attempted by pushing and prying the

FIG. 1299.—McBurney.

head of the bone with elevators, forceps, and McBurney's ingenious hook (Figs. 1298 and 1299). Free division of resisting bands is of course necessary. After successful reduction, the fractured bones must be united by suture (wire, chromicized catgut) or by buried metallic pinning. In fracture-dislocation of the humerus operation may be performed immediately [illegible] before the lymphatics have become clogged with debris in process of removal, or late, i.e., after

the lymphatics have removed the débris of destroyed tissues and effused blood and before real attempts at repair of bone have begun.

As after-treatment passive motion must be begun early (about the tenth day).

Instead of exposing the joint by means of Ollier's incision Catterina's method may be used.

Dollinger ("Zentralblatt für Chir.," Dec. 6, 1902) in seven cases found remarkable absence of callus, scar tissue, etc. He operated with excellent results in the following manner:

Step 1.—Incise from the clavicle to the insertion of the pectoralis major along the inner side of the cephalic vein. Penetrate the cleft between the deltoid and the pectoralis major and expose the coracoid process (Fig. 1300).

FIG. 1300.—Old dislocation of shoulder. (*Dollinger.*)

Step 2.—Retract the pectoralis minor up, the coraco-brachialis out, and the pectoralis major inwards. Expose the bicipital groove and lesser tuberosity. Do not injure the long head of the biceps. The humeral head lies posteriorly and rotated somewhat inwards (Fig. 1301).

Step 3.—Rotate the upper arm outwards, thus bringing into the wound the subscapular and the head of the humerus covered by it (Fig. 1302).

Step 4.—Divide the tendon of the subscapularis and expose the head of the humerus (Fig. 1303). It is possible to rotate the bone outwards to any extent required and so Kocher's method of manipulative reduction becomes easy. According to Dollinger, the retracted and perhaps sclerosed subscapularis forms the obstacle to reduction in uncomplicated cases and under it lies the head of the humerus in subcoracoid dislocation. If, as happened in one of Dollinger's cases, reduction is impossible after section of the subscapular tendon, pull the arm strongly downwards, continue the split in the tendon to the glenoid foosa and remove any obstruction present. Sometimes reduction by arthrotomy

proves impossible. Under these circumstances decapitation of the humerus and removal of the head is proper, unless a new joint has formed giving satisfactory function. Usually there is great pain and disturbance due to pressure

FIG. 1301.—Old dislocation of shoulder. (*Dollinger.*)

on the vessels and nerves. The operation is essentially the same as that for reduction of the dislocation, but the head of the bone is removed after section of its neck by means of a Gigli wire saw. Enough bone must be removed to insure

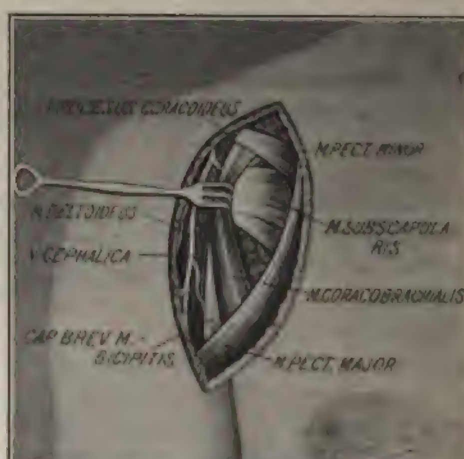


FIG. 1302.—Old dislocation of shoulder. (*Dollinger.*)

a good new joint. As an aid to the making of a new joint one may cover the divided end of the humerus with the flap of muscle or, better, of fascia and fat.

Regarding excision, Jonas writes: "This is an operation to be avoided when

possible, on account of the resultant flail-like condition of the arm and yet must be done (*a*) when the humeral head and neck become too extensively stripped of their attachments, experience having shown that necrosis may occur in 16 per cent. (Souchon) of the cases; (*b*) when osseous union has occurred between the head and the ribs; (*c*) when, after a division of all the restraining soft parts, the head rests against the point of the acromion process" ("Annals Surg.," May, 1903).

In case of osseous union between the head of the humerus and the ribs it would seem to the author better when possible to divide this union, trim away irregularities from the head of the bone, cover it with a pedunculated flap of fat and fascia and reduce it, thus forming a new joint with the minimum loss of substance.

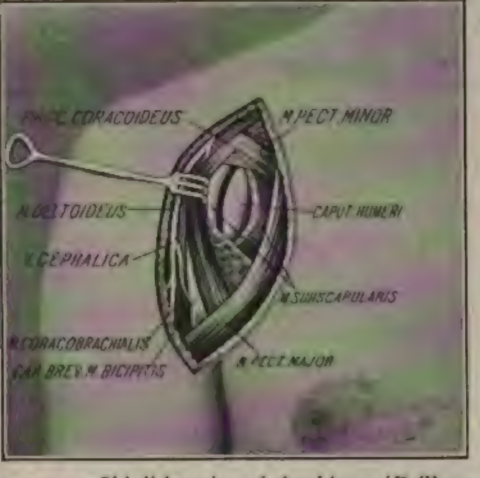


FIG. 1303.—Old dislocation of shoulder. (*Dollinger.*)

In his classical paper on irreducible shoulder dislocations ("Transactions Am. Surg. Assoc.," 1897) Souchon comes to the following conclusions regarding anterior displacements: "The anterior incision is the route. Reduction is the more desirable operation, because it preserves the head and all the movements depending thereon. Reduction should be done only in cases where the head and glenoid cavity are in good condition; when no extensive dissections have to be made; when it is easily effected without any great effort; when the head does not need to be trimmed or the cup to be too deeply scooped or enlarged; when the head readily remains in place, but not too tightly. All this regardless of the time or standing of the dislocation. It should, however, always be attempted conscientiously, because many have resected, perhaps, when the dislocation could have been reduced. Disregard of these rules may result in necrosis of head, in recurrence of the dislocation or in anchylosis, with their inevitable consequences. Resections should be practised in all other cases. When in doubt it is preferable to resect. How much to resect, *i.e.*, whether to saw,

through the anatomical neck, or obliquely and downwards outside the tuberosity, or horizontally on a level with the lower margin of the head, must be determined in each case; it is best to remove too much than too little." The last remarks of Souchon require some modification. In subjects under eighteen years of age it is most important not to injure the epiphyseal cartilage between the head and the shaft (Fig. 1304). "A horizontal section with the saw, starting at the internal insertion of the capsule around the head, will surely carry away the totality of the conjugating cartilage. In young children, if the resection is made below the epiphyseal cartilage, the arm will cease to grow. The resected extremity should not be pushed into the glenoid cavity in children, lest the growth of bone cause anchylosis" (Souchon).

FIG. 1304.—(*Morris.*)
Ossification of the humerus; the figure also shows the relations of the epiphyseal and capsular lines.

Posterior or Subspinous Dislocation Shoulder.—These dislocations are commonly congenital. Scudder's rule for distinguishing between the congenital and traumatic varieties is that in the former the scapula, clavicle and arm bones are not so well developed as on the sound side. Only a few operations have been performed for "irreducible" dislocations of the above kind and of these Phelps's operation seems to have given the best results. Phelps's operation is thus described in Souchon's monograph: "Curved incision along the lower edge of the deltoid and on to the scapula, and flap turned down; it would be best to curve the incision downwards and turn the flap upwards, as it would give better drainage.

Difficulties and complications of the operation: The posterior edge of the glenoid cavity was gone and the cavity was about two-thirds the normal size; a portion of the head of the humerus was cut away in order to fit it to the socket; also cut away a portion of the redundant capsule posteriorly; the bone replaced and a stitch put in behind to help retain the head in place.

Complications after the operation: None. Result immediate: Drainage-tube left a week. Result remote: Is satisfactory. Dr. A. P. Dudley saw the patient a year after the operation, and there was a little difference between the two arms. Remarks: Dr. Dudley did not doubt that the injury had occurred during delivery. Doctors who had seen the patient before were of the opinion that it was one of paralysis. Dr. A. M. Phelps says that the method promised success during the first year, although one case has been operated in which it was successful at the fifth year."

In another case in which reaction of degeneration was present, apparently due to pressure neurosis, the result obtained by Phelps was not so perfect, but the reaction of degeneration disappeared.

Peckham ("Am. Journ. Orthopedic Surg.," April, 1905) reports two cases in which he obtained improvement by means of Phelps's procedure.

Dislocation plus Fracture of the Head of the Humerus.—In 117 cases of the above injury the fracture was located at the surgical neck in sixty-nine, at the anatomical neck in twenty-seven, at the "neck" in eleven, at both surgical and anatomical necks in six; one case was comminuted, and the "upper part" of the humerus was fractured in three (McBurney and Dowd). In the aged, the feeble, and perhaps in diabetics and some nephritics, etc., it is wise to adopt Riberi's treatment *provided* that the head of the bone is not giving rise to pain and other pressure symptoms. This treatment (Riberi's) consists of massage and passive, later, active motion, and aims at the production of a pseudarthrosis. In all other cases more active treatment is necessary. Never fail in recent cases to attempt reduction, under an anesthetic, by means of manipulation and finger pressure applied to the dislocated head of the humerus. This is occasionally successful and the condition becomes one of mere fracture. Never attempt reduction by any of the manipulations suitable in uncomplicated dislocation. It is wise to be prepared to proceed at once to arthrotomy if simpler means fail.

Arthrotomy for Fracture-dislocation of the Humerus.—McBurney's Operation.—Make an incision about 1½ inches long about 1 inch below the acromion. Penetrate the deltoid to the outer surface of the upper fragment. Drill a hole through the upper fragment horizontally. (This supposes fracture at or near the surgical neck.) Into the perforation fit the right-angled beak of McBurney's traction hook (Figs. 1298 and 1299). Make traction on the upper fragment by means of the hook and at the same time press with the fingers on the head of the bone and so reduce it. Treat the fracture *secundum artem*. Farquhar Curtis has found McBurney's hook tear out during the necessary traction but by using leverage with a periosteal elevator and by dividing obstructing bands he succeeded in obtaining reduction.

Schlange's Operation.—("Archiv für klin. Chir.," lxxxi, II, Theil). Abduct the arm. Make a 4½ inch incision along the axillary margin of the pectoralis major and coraco-brachialis. Retract these two muscles forwards, retract the axillary vessels and nerves backwards and protect them. Incise the joint capsule or enlarge (if necessary) any tear which may involve the capsule and so

expose the heads of the bone. Remove any splintered fragments of bone. Reduce the dislocated humeral head by direct manipulation with the fingers and by prying with blunt instruments. Schlange operated in this manner on one case of fracture of the anatomical and in one of the surgical neck. In the former case the question of resection presented, as the head of the bone was separated from almost all its connections; "the good result obtained demonstrates that one dare to and ought to act very conservatively just as in the case of a dislocated astragalus." This advice of Schlange's is good when the patient is in the hands of a first class surgeon and in proper surroundings, but there are circumstances in which resection is much safer and will give an excellent functional result, especially if the upper end of the humerus be covered with Murphy's flap of fatty fibrous tissue.

Codman's (Sabre-cut) **method** of exposing the shoulder is described on p. 1125.

Arthrodesis Shoulder.—When, as a result of paralysis, the shoulder-joint becomes flail-like and yet the muscles of the elbow and of the hand and those uniting the scapula to the trunk are not paralyzed, the operation of arthrodesis may be useful. If the elbow muscles are also paralyzed but those for the hand remain active, artificially produced anchylosis (arthrodesis) of both shoulder and elbow may be of service.

Step 1.—Exposure of the joint. Owing to the degeneration of the deltoid and of the circumflex nerve in cases of paralytic luxation it is useless to pay much attention to these structures, hence incision may be made where convenient ("Bothezat, Rev. de Chir.," June, 1901).

From a point a little internal to the acromio-clavicular joint make an incision downwards to the outer side of the pectoro-deltoid groove for a distance of 1½ to 4 inches.

Step 2.—The deltoid being practically absent, it is very easy to open the joint by cutting the capsule along the bicipital groove.

Step 3.—Excise as much of the synovialis as possible and scrape with the spoon every accessible part of the remainder.

Step 4.—Push the head of the humerus out of the wound. This is easy because all the tissues are relaxed and the muscles paralyzed. Remove all cartilage from the head of the bone. Vivify the glenoid cavity by removing the cartilage. Vivify an appropriate surface of the acromion process.

Step 5.—Let an assistant steady the scapula in good position. Place the humeral head in contact with the glenoid cavity and the acromion process. The most useful position (Bothezat) is one of slight internal rotation with the arm at an angle of 45° to the external border of the scapula. Fix the bone in position by means of two wires, one uniting the humerus to the upper part of the glenoid, the other uniting the humerus to the acromion.

Step 6.—Close the wound by deep and superficial sutures, being careful to "take up the slack" in the capsule. Immobilize. After the wound has completely healed treat the muscles by means of massage and electrical stimulation, but keep up immobilization for two months, *i.e.*, until consolidation has had time to take place.

Habitual Dislocation Shoulder.—Burrell operates by excising a portion of the capsule in the following manner:

Make Ollier's anterior incision.

Expose the coraco-brachialis, short head of the biceps, and upper part of the tendon of the pectoralis major below; divide the upper three-fourths of the tendon of the pectoralis major at its insertion and so expose the head of the humerus and part of its shaft.

Rotate the arm outwards and push the elbow a little backwards, exposing the tendon of the subscapularis stretched over the head of the bone. Divide the upper portion of this tendon. Abduct the arm to an angle of 45°; press the head of the bone backwards so as to relax the capsule anteriorly. Excise a strip of capsule about ¾ inch long by ⅜ inch wide. Suture the wound in the capsule. Close the wound. Dress. Immobilize. A. I. Mackinnon improves Burrell's operation by avoiding excision of the capsule and by closing the wound in an overlapping fashion. The operation consists "in doing an open arthrotomy; the muscles are well retracted and the capsule is opened from the coracoid process downwards. Mattress sutures are introduced 1 to 1½ inches from one margin of the incision in such a manner that when they are tied one flap slides under the other. By this process there is a double layer of capsule over what is ordinarily the weakest point, and increased protection against recurrence is given the joint. A running suture closes the exposed margin of the capsule, and the external wound is closed in the usual manner." In similar cases Robert Jones often cuts down to but *not* into the capsule; seizes the capsule with two forceps, twists it tight and with sutures fixes the folded or twisted capsule so that it cannot relax.

Turner Thomas ("Journal A. M. A.," March 12, 1910) performs capsulorrhaphy through an incision in the axilla.

Step 1.—Make a cut in the axilla along the coraco-brachialis muscle from the side of the chest downwards for about 5 inches. Retract outwards the coraco-brachialis, biceps and pectoralis major. Retract inwards the axillary vessels and nerves as well as the musculo-cutaneous nerve. Doubly ligate and divide the anterior circumflex vessels and expose the latissimus dorsi in the floor of the wound. Locate and protect the circumflex nerve and the posterior circumflex vessels as they pass backwards. On a grooved director divide about half the width of the subscapular muscle, thus exposing the capsule.

Step 2.—Open the capsule by a cut about 1½ inches in length, in the line of the anterior glenoid margin and about ½ inch below it. Explore the joint for any obstruction to reduction.

Step 3.—Close the wound in the capsule by the overlapping method. Repair the wound in the subscapularis. Close the wound. Bind the arm to the side and support the wrist in a sling.

After-treatment.—On the ninth day the patient may put his arm through the sleeve of his coat. For three weeks keep the arm bound to the chest during the night. After which time forcible movements may be begun. Thomas finds

that patients become able to raise their arms straight above their heads in from six to fifteen weeks after operation.

Clairmont-Ehrlich Operation.—Make an incision over the anterior portion of the deltoid and parallel to its fibres. Split the muscle.

Make an incision over the posterior portion of the deltoid and reflect upwards a flap of deltoid preserving intact the branches of the axillary nerve supplying it.

From the anterior incision pass a closed forceps through the split in the deltoid around the inner side of the humeral neck to emerge at the posterior deltoid around the inner side of the humeral neck to emerge at the posterior deltoid wound. Grasp the mobilized flap of muscle, pull it through the tunnel, which has been sufficiently dilated to accommodate it, and suture it to the anterior deltoid wound. The whole operation is extra-capsular.

Clairmont and Ehrlich obtained good results in two cases.

In three cases of Lameris the immediate results were good but in two of them there was recurrence after eleven months. Seidel found that the longest muscle flap obtainable might be too short to reach to the anterior deltoid wound, so in one case he lengthened it by a graft of fascia with unfavorable result.

Kirschner's Operation.—*Step* 1.—Beginning ¾ inch below the middle of the spine of the scapula make a 2½–3 inch incision along the posterior margin of the deltoid. Expose the posterior margin of the deltoid and retract it upwards and outwards.

Step 2.—Recognize the circumflex nerve and vessels. Using these as a guide find the quadrilateral space bounded above by the teres minor; below by the teres major; internally by the long head of the triceps; and externally by the humerus. Retract the circumflex nerve and vessels downwards; bluntly penetrate the quadrilateral space.

Step 3.—Push the finger or a forceps forwards and upwards under the deltoid to the posterior edge of the acromion near its point. At this place make the forceps penetrate the deltoid and lift up the skin. Incise the skin over the point of the forceps.

Step 4.—Make an incision along the anterior margin of the deltoid and expose its border. With finger and forceps burrow under the muscle to the anterior margin of the acromion near its point and perforate the muscle. Push the perforating forceps through the skin incision made in Step 3.

Step 5.—Through the anterior incision pass the finger or forceps around the neck of the humerus, hugging the bone, to emerge at the posterior incision.

Step 6.—From the thigh excise a strip of fascia lata about 8 inches long by 1¼ inch wide. Pull this through the tunnels which have been made around the shoulder. The course of the implant as it is pulled into place is (*a*) through the posterior incision, (*b*) through the quadrilateral space between the teres major and minor, (*c*) under the neck of the humerus to the anterior incision, (*d*) under the deltoid to the perforation in that muscle just in front of the acromion, (*e*) over the acromion (*f*) from without inwards, through the perforation in the deltoid and so under the deltoid to the posterior incision again, where it is fixed by a few sutures.

The result is a strip of fascia, outside the joint capsule, which slings the neck of the humerus to the acromion process.

Payr's Operation (Kleinschmidt, "Ergeb. d. Chir. u. Orthop.," viii, 229).—Expose the joint capsule through Ollier's incision. Suture the base of a triangular flap of fascia lata by several rows of sutures to the insertion of the pectoralis major.

Under tension suture the apex of the flap to the coracoid process. Through a suitable incision behind expose the posterior margin of the deltoid and retract it upwards and outwards. Suture the apex of a triangular flap of fascia lata to the joint capsule above the head of the humerus. Suture the base of this flap, under tension, to the surface of the infra-spinatus and teres minor. Several rows of suture should be used.

Perthes ("Deutsche Zeitschrift für Chir.," lxxxv) believes habitual dislocation of the shoulders is generally due to fracture of the upper end of the humerus or of the scapula. Owing to muscular action or to direct violence the greater tuberosity is often fractured or the tendons give way near their insertion there, and are likely to unite to the capsule. In other cases the glenoid may be injured, giving rise to foreign bodies in the joint. Sometimes the trouble is due to relaxation of rupture of the capsule. The capsule is normally so large that it is capable of holding two humeral heads or of permitting subcoracoid dislocation (Perthes). It may be enlarged uniformly or the anterior part may be enlarged and form a sort of hernia.

In operating always open the joint to look for damage to the bones and tendons. If the tuberosity is fractured or the tendons torn off from it, the injury must be repaired, or the joint will not be secure. The best method of joining the ruptured tendons to the bone is by double-pointed steel tacks (Perthes) which are either driven through the tendons into the bone or are first driven into the bone and the tendons then secured to them. The glenoid ligament may be fastened to the neck of the scapula in the same fashion. Perthes exposes the joint by turning backwards and upwards a flap of skin and of the whole deltoid muscle. This exposes the joint very well and the muscle is said not to suffer from the disinsertion, if sewed in place firmly. The joint may be reached from in front by an incision along the border of the deltoid, the anterior portion of which is severed near the clavicle. The tendon of the pectoralis major is cut and this muscle is drawn towards the breast. The end of the coracoid process is removed with a Gigli wire saw and the coraco-brachialis and short head of the biceps drawn down. The upper border of the subscapularis may be drawn back or severed. After suturing the tendons of the scapular muscles and repairing the glenoid ring, the capsule is drawn up with sutures so placed as to strengthen it. The muscles cut during the operation are then restored and the skin closed.

Arthroplasty of Shoulder.—The general principles governing the operation of arthroplasty are described on page 1064.

Step 1.—Expose the joint through Ollier's incision.

Step 2.—Overcome the anchylosis. In bony anchylosis resection and model-

ling of the head of the humerus will be necessary. See that motion is even more than normally free.

Step 3.—*Method* A.—Through an incision parallel to its fibres, expose the surface of the middle portion of the pectoralis major. Mobilize a flap from the pectoralis major, the pedicle of the flap being formed by its humeral insertion (Fig. 1305, Payr). Make a subcutaneous tunnel from the wound on the

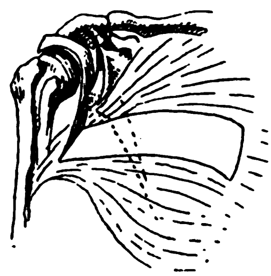


FIG. 1305.—Arthroplasty. (*Payr.*)

chest to that opening the joint and pull the pectoral flap through the tunnel into the joint. Wrap the flap over the head of the humerus and fix it in position by a few sutures.

Method B.—Exactly the same as method A but the flap is formed of the fat and fascia covering the pectoralis major instead of muscular tissue.

Method C.—Carefully wrap the head of the bone in Baer's membrane (see p. 1067).

Step 4.—Close the wounds. Apply dressings.

CHAPTER XCIII

CLAVICULO-HUMERAL NEARTHROSIS

It is interesting and valuable to know that a useful new joint can be established after excision of the scapula and of the upper end of the humerus even when a useless flail-like articulation has been present for a long time. Ollier's case presents so many points of interest and his treatment of it is so suggestive in many ways that no apology is necessary for discussing it at some length.

FIG. 1306.—(*Ollier.*)

The patient was wounded in the shoulder in 1871. He subsequently underwent many operations—sequestrotomies, typical resection of the humeral head, complete removal of the scapula, etc., etc. ("Revue de Chir.," July, 1899). Figure 1306 shows the appearance of the patient. The outer end of the clavicle was pulled upwards by the trapezius and was connected with the humerus merely by skin, fibrous tissue, and some atrophied bands of muscle. The arm itself drooped because of its own weight. The limb was useless

though the muscles of the forearm and hand were well nourished. The u end of the humerus was thin, pointed, surrounded by scar tissue, and a $2\frac{3}{4}$ inches distant from the clavicle. The muscles of the shoulder we atrophied that only with difficulty could remnants of them be found ar the scars of the incisions existing where the scapula had been. The de had lost all its clavicular connections except its inner fibres which were stret and atrophied. The rest of the deltoid had retracted to its lower inser curling itself up in a bunch over the upper end of the humerus. The pectc major formed the principal support of the arm.

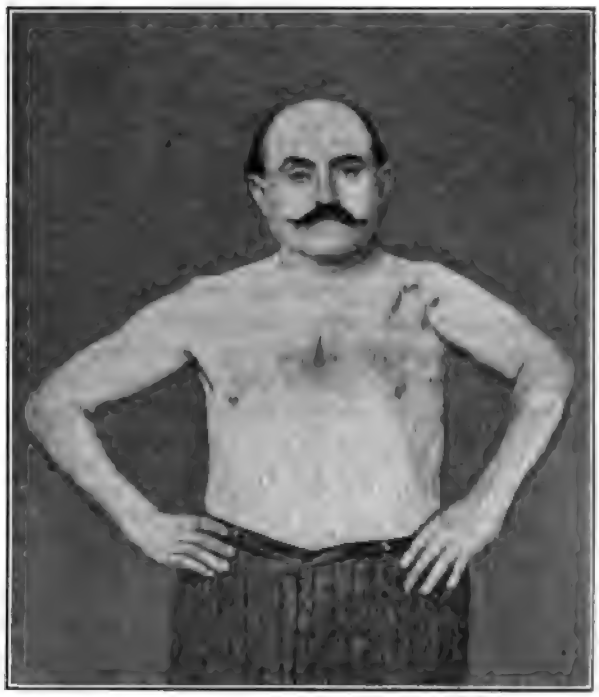


FIG. 1307.—(*Ollier.*)

Ollier operated as follows:

(1) Antero-lateral incision from the outer end of the clavicle downwards

(2) Vivification of the under surface of the clavicle for an area of ab $1\frac{1}{2}$ square inches. This was done by turning aside a flap of periosteum.

(3) Extension of the incision sufficiently to permit the formation of a cav through which the humerus could be brought into contact with the clavi (care was here required to avoid injuring the vessels and nerves. It necessary to excise some of the scar tissue before the humerus could be broug into proper position.

(4) Cutting off the pointed extremity of the humerus in order to obtai surface large enough to unite to the clavicle. When removing the bone Ol preserved its periosteum.

(5) Drilling of two holes through the clavicle and two holes (from before backwards) through the humerus. Wiring of the humerus to the clavicle.

(6) Suture of the periosteum of the humerus to that of the clavicle (*i.e.*, the reflected flaps of periosteum).

(7) Dissection and straightening out of the periarticular muscles so that they could be sutured where they would do most good, *e.g.*, the deltoid which was curled up on itself was freed from adhesions and then sutured to the trapezius which was separated from the clavicular insertion; such portions of the deltoid as did not correspond to portions of the trapezius were sutured to the periosteum and tissues around the clavicle.

(8) Closure of the wound. The limb was immobilized for four months, but during that time the deltoid was stimulated by electricity applied through a window cut in the dressings. After the above time no bony union had taken place. In time a useful and movable joint formed. Figure 1307 shows the patient twenty-five months after operation.

CHAPTER XCIV

OPERATION FOR SUBACROMIAL BURSITIS AND FOR RUPTURE OF THE SUPRA-SPINATUS TENDON

Codman's Bursitis is more common than any other lesion of the shoulder or inflammation of any other bursa. Normally, a bursa exists between the deltoid and acromion and the short rotators which form the capsule of the shoulder. When the arm hangs at rest a small portion of the bursa extends under the acromion process and the coraco-acromial ligament. When the arm is abducted the base of the bursa which is on the tuberosity of the humerus passes upwards under the acromion and the coraco-acromial ligament. When bursitis is present abduction and likewise external rotation become impossible.

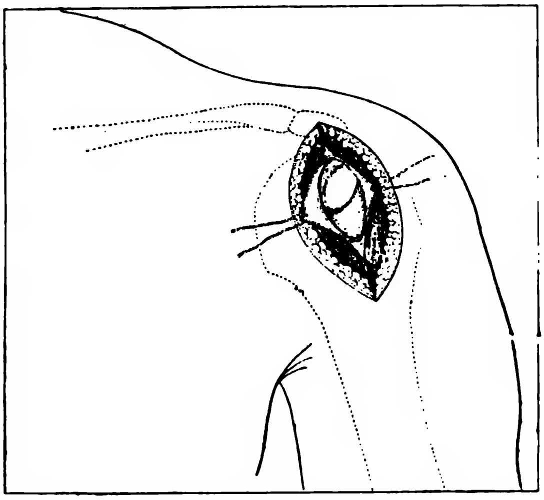


FIG. 1308.—Codman's bursitis. (*Codman.*)

In chronic inflammation the normally thin and pliable bursal walls become thickened, and if simpler means of treatment fail, excision becomes necessary.

The Operation.—*Step* 1.—From a point midway between the coracoid and the acromion make a 2 to 2½-inch incision parallel to the fibres of the deltoid (Fig. 1308). Split the deltoid and enter the bursa as if it were the peritoneum.

Step 2.—Excise the adherent or thickened portion of the bursa.

Step 3.—Attend to hemostasis. Close the wound in the deltoid with fine catgut sutures. Close the skin wound. Apply dressings. Begin motion in about ten days.

Brickner ("Am. J. Med. Sc.," March, 1915) notes that contusions or tears : the supra-spinatus tendon, even when the trauma is mild, are sometimes llowed by single or multiple deposits of lime salts in the tendon or on its rface. When such are present and cause disability their removal is necessary. ickner operates for Codman's bursitis as follows: Open the bursa through an cision which splits the deltoid from the outer border of the acromion downrds over the greater tuberosity, *i.e.*, towards the external condyle. With tractors open the bursa. Divide all adhesive bands. Excise any papillomae masses. Explore the whole bursa rotating and putting traction on the arm may be necessary to facilitate palpation. Incise the floor of the bursa, in e same line as the skin incision, over the greater tuberosity and supra-spinatus sertion and dissect it up from the tendon. If any deposit, fluid or solid is und, remove such. If the tendon shows any superficial injury or tear within hich is more of the solid or cheesy material, clear such away and trim and suture

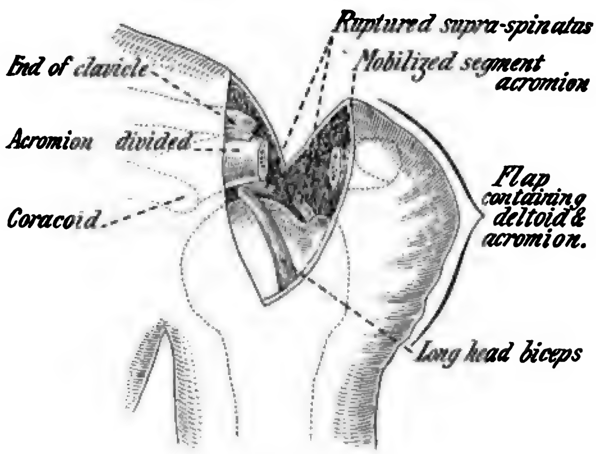


FIG. 1309.

e rent in the tendon. If the X-ray has shown calcareous material in the ten- n, completely remove such through an axial split in the tendon and suture e wound with catgut. Close the wound in the floor of the bursa with fine tgut stitches. Smear the inside of the bursa with vaseline but leave no nall lumps of the lubricant. Suture the roof of the bursa. Close the wound. ress. Immobilize the arm in a position of abduction (120°) until healing has ken place.

Injury to the Supra-spinatus Tendon.—Codman has shown that the deltoid n act efficiently as an abductor only after the supra-spinatus has pulled the ad of the humerus firmly against the scapular portions of the articulation; us rupture of this tendon causes great disability and must be repaired. The eration is best carried out through *Codman's sabre-cut incision* which is very luable for exploration of the joint and for the treatment of fracture—discation or of irreducible dislocations. The operation is not suitable for tuber- [illegible] inflammatory lesions.

The Sabre-cut Operation.—Split the deltoid exactly as in exposing the subacromial bursa. Continue the incision directly back over the shoulder at the root acromion process. Divide the acromio-clavicular joint. With a Gigli saw divide the base of the acromion avoiding injuring the supra-scapular nerve as it passes through the great scapular notch. (Fig. 1309). Divide a few fibres of the trapezius and retract outwards the acromion along with the deltoid and the whole outer half of the wound just as if one opened the upper part of the seam of a coat sleeve and looked in at the top of the shoulder. If the supra-spinatus has been torn, the articular surface of the joint is visible; otherwise (if the operation is exploratory) that muscle must be divided before proper exposure is attained. It is easy to repair the tendon with sutures and to suture the acromio-clavicular joint by means of the surrounding firm fibrous tissue. The acromion may be united either by wiring or by suture of the surrounding soft parts.

CHAPTER XCV

ELBOW

Intra-articular Injection.—The technic of intra-articular injections has been so fully treated elsewhere that it is sufficient to mention the point of puncture of the elbow-joint. Recognize by palpation the head of the radius. From the outer side of the arm introduce a trocar at right angles to the long axis of the limb, immediately above the radial head, and penetrate into the joint.

Resection or Excision of the Elbow. Posterior Vertical Median Incision.—*Step* 1.—Have an assistant hold the arm firmly in a position of partial flexion. Make a longitudinal incision from a point 2 inches above, to a point 2 inches below, the tip of the olecranon (Fig. 1310). The cut, following the middle line of the olecranon and lower part of the humerus, penetrates at once to the bone and opens the posterior part of this joint.

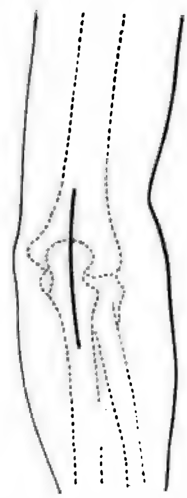


FIG. 1310.—Excision of elbow.

Step 2.—With a periosteal elevator or knife separate all the soft parts (including periosteum and inner portion of triceps tendon) from the olecranon process on the inner side of the vertical wound. In doing this, if one uses the knife, one must strongly retract the tissues inwards with the nail of his left thumb and cut with *short* decided movements of the knife *on to the bone*. As such a manner of cutting is essential, but soon renders the knife as blunt as the proverbial ploughshare, it is well to have several knives prepared. *In all the cutting practised in resection of the elbow the edge of the knife must be directed against the bone* (Fig. 1311).

Continue the separation inwards until not only is the inner part of the olecranon bare of covering, but the same is true of the inner part of the lower end of the humerus and the internal epicondyle can be protruded into the wound.

The ulnar nerve lying in the groove between the olecranon and the internal condyle is raised up and retracted inwards with the rest of the soft structures (Fig. 1312). It should not be seen. The structures on the outer side of the elbow are to be treated in the same way as those on the inner side. The manœuvres described effect a complete decortication of the posterior and lateral surfaces of the bones forming the elbow.

Step 3.—Flex the elbow completely. Push the lower end of the humerus out of the wound and separate it from the soft structures in front to the desired extent. With a flat piece of metal (retractor or spatula) protect the soft parts

in front of the elbow. Seize the lower end of the humerus with lion-jawed forceps and remove with a saw as much of it as seems desirable (Fig. 1313). Any operating saw is suitable. (Some surgeons use a butcher's saw with its sawing edge turned towards the bow of the instrument. The sawing ribbon is placed in front of the bones while the bow is behind them, the bone is sawn through backwards, and all danger to the vessels anterior to the joint is averted.)

With the elbow still flexed, make the upper ends of the radius and ulna protrude through the wound and saw them off with the same precautions.

Step 4.—Review the wound to see if all osteal disease has been removed. Any diseased synovialis which may be seen must be cautiously and thoroughly removed by dissection.

How much bone ought to be removed? The line of section of the ulna should permit removal of the greater and lesser sigmoid cavities with the

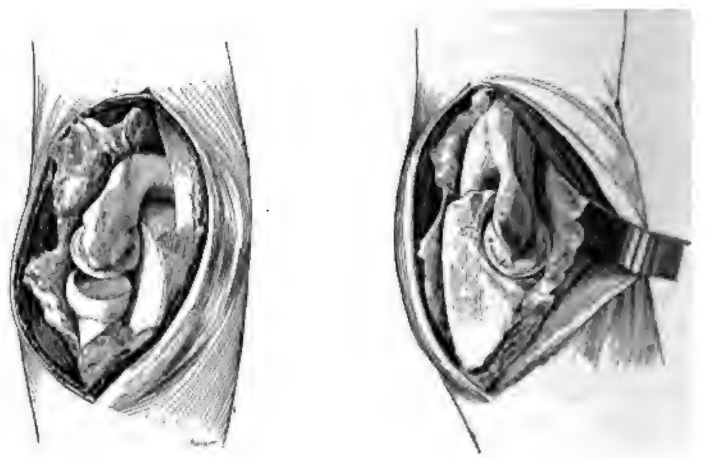


FIG. 1311. FIG. 1312.
FIGS. 1311 AND 1312.—Excision of elbow. (*Schwartz.*)

olecranon. The radius should be divided at the same level just below its head, above the biceps. Jacobson writes, regarding section of the humerus: "An insufficient amount is usually removed here, and limitation of subsequent movement thereby invited. It is generally considered sufficient to remove all the articular cartilage, the section being made to pass through the lower part of the coronoid and olecranon fossæ, and below the level of the epitrochlea on the inner, and through the epicondyle on the outer side. This is not enough. The saw should pass at a higher level, *i.e.*, above the level of the epicondyle, and through the highest part of the epitrochlea, removing quite the lower two-thirds of this process. This is the very lowest level at which the surgeon should hold his hand if he desires to obtain good movement. And before he is satisfied on this point he should place the fingers of the affected limb, not only on the opposite shoulder and mouth (as is often done), but on the shoulder

of the same side, and behind the back to the angle of the opposite scapula. Unless these movements are perfectly free, he should take another thin slice off the humerus, removing the whole epitrochlea. This step may seem to my younger readers a needless shortening of the limb, and likely to lead to a flail-joint. I can assure them that it is not so. As long as the elbow-joint is freely movable, shortening of the bones matters very little. If attention has been paid to the advice given and the soft parts separated very carefully and, as far as possible, subperiosteally from the epicondyle and epitrochlea, the joint will become sufficiently steady laterally as well as freely movable, although these bony prominences have been freely removed. Another test

FIG. 1313.—Excision of elbow.

which the surgeons should always apply before considering the section of the bones completed is the interval between the sawn ends. Prof. Annandale considers that 1½ inches should intervene between them when the bones are extended." This valuable advice of Jacobson does not apply when one covers the sawn surfaces of the bone with a flap of fascia and fat. If the operation has been undertaken for tuberculosis, rub iodoform into all raw surfaces. Suture. Provide drainage. Dress. As an alternative, fill the wound cavity with iodoform emulsion or its equivalent and close without drainage. It is generally recommended to place the partially flexed limb in a metal splint provided with an adjustable joint opposite the elbow. The young surgeon, especially in the country, will generally be without such apparatus, but in the author's experience a starch or light plaster bandage strengthened with

strips of pasteboard or wire netting answers all purposes. The after-treatment is the same as that described in the chapter on the operative treatment of old dislocations of the elbow.

Kocher's Method.—Kocher is true to his principle that in arthrectomy it is far better to make a complicated skin incision than a simple one, if by so doing one can preserve intact not merely the muscles, but their nerve supply. Flex the arm to an angle of 150°. From a point 1½ to 2 inches above the articular line make an incision downwards along the outer edge of the humerus to the head of the radius (Fig. 1314). Continue the incision downwards along the outer margin of the anconeus to the ridge of the ulna about 2 inches below the tip of the olecranon. The incision is curved and should end a little to the inner (ulnar) side of the ulna. At the upper end of the incision, penetrate to the outer edge of the humerus by separating the supinator longus and the extensor carpi radialis longior in front from the triceps behind. From the external condyle downwards penetrate between the extensor muscles (extensor carpi ulnaris, etc.) in front and the anconeus behind, until the ulna is reached. In doing this the lower fibres of the anconeus must generally be divided. The rest of the operation requires no special description.

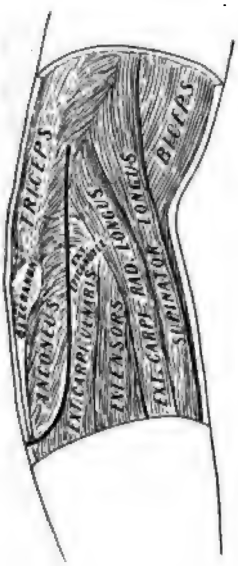


FIG. 1314.—Kocher's incision.

Ollier's Bayonet Incision.—From a point 2¼ inches above the joint-line make a vertical incision along the outer margin of the humerus between the triceps and supinator longus to the tip of the external condyle. From the tip of the condyle continue the incision downwards and inwards to the base of the olecranon, then change the direction of the incision once more so as to make it follow the posterior border of the ulna downwards for 1½ to 2 inches (Fig. 1315). Make a second incision, 1 inch long, over the internal condyle.

Posterior Flap Operation.—Morison operates as follows: From a point over the internal condyle make an incision upwards for about 2 inches, corresponding to the inner intermuscular septum. Make a similar incision on the outer side of the limb (Fig. 1316). Join the upper ends of the two vertical cuts by a curved transverse incision, the upper convexity of which is 3 inches above the olecranon. Expose the ulnar nerve through the inner incision and protect it. Turn down the skin flap outlined for a distance of 1 inch. Divide the triceps transversely. Turn the skin flap and triceps tendon downwards. The rest of the active operation requires no special description. Close the wound by stutring the divided triceps and then the superficial wound. Morison permits no motion for two weeks, after which time he keeps the limb extended at night and fully flexed during the day.

Bardenheuer's Operation (Lossen, "Deutsche Zeitschrift für Chir.," xii, 120). **Extra-capsular Arthrectomy.**

Step 1.—Reflect a horseshoe-shaped flap of skin, having its pedicle above, from the posterior aspect of the joint.

Step 2.—Divide the triceps tendon above the olecranon.

Step 3.—By dissection lay bare, but do not penetrate, the posterior and lateral surfaces of the articular capsule.

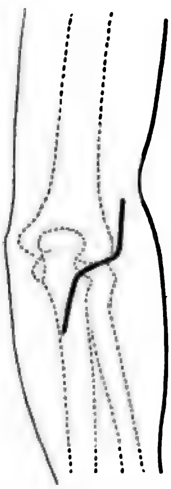


FIG. 1315.—Ollier's incision.

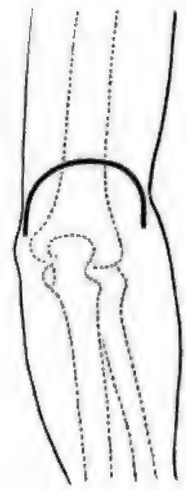


FIG. 1316.—Rutherford-Morison's incision.

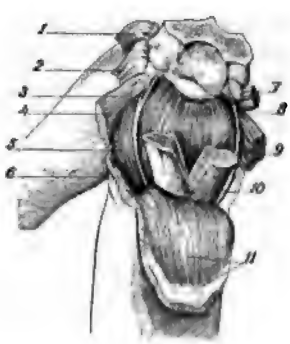


FIG. 1317.

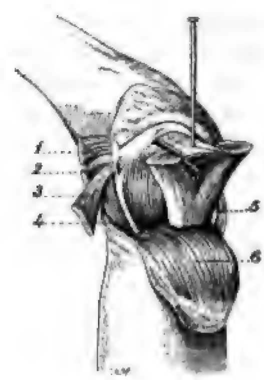


FIG. 1318.

FIGS. 1317 AND 1318.—Bardenheuer's operation. (*Lossen.*)

FIG. 1317.—1. Anconeus. 2. Ext. digitorum. 3. Division musculo-spiral nerve. 4. Ext. carpi radialis longior. 5. Supinator longus. 6. Musculo-spiral nerve. 7. Pronator radii teres. 8. Brachialis anticus. 9. Flexor muscles divided. 10. Ulnar nerve. 11. Tendon of triceps.

FIG. 1318.—1. Anconeus. 2. Extensor com. digitorum. 3. Division musculo-spiral nerve. 4. Ext. carpi radialis longior. 5. Supinator longus. 6. Musculo-spiral nerve.

Step 4.—Divide the humerus and retract its articular end downwards (Fig. 1317), thus exposing the anterior surface of the joint.

Step 5.—Separate the overlying soft structures from the anterior surface of the capsule.

Step 6.—Divide the ulna. At a lower level divide the radius. (The section

of the radius at a lower level than that of the ulna is important for the preservation of pronation and supination.) The articular ends of the bones plus the whole joint cavity can now be removed in one piece.

Step 7.—With chisel, forceps, or saw cut a V-shaped notch in the humerus (Fig. 1317). Trim the upper end of the ulna so as to fit into the notch in the humerus while the forearm is held in a position of a little less than a right angle to the upper arm. Unite the ulna to the humerus by means of a nail (Fig. 1318).

Step 8.—Close the wound.

Atypical Resection of the Elbow.—Access to the joint is obtained through the posterior longitudinal incision already described. The base of the olecranon process is cleared of its coverings and divided transversely either from without inwards with a chisel, or from within outwards with a Gigli wire saw. The olecranon is reflected upwards with the attached triceps tendon. Examine the olecranon carefully as it is the most common site of osseous foci of disease in tuberculosis of the elbow. With a chisel or sharp spoon remove diseased bone wherever found. With forceps and knife or scissors excise diseased soft structures. Thoroughly cleanse the joint cavity. Reunite the olecranon to the ulna with bone pegs, steel nails (the ends protruding through the wound), silver wire, or chromicized catgut. Close the wound, provide for drainage, and dress. Many surgeons advise that the limb be kept in an extended position for two weeks. The after-treatment is practically the same as that for other elbow-joint resections.

Fritz König ("Zent. f. Chir.," xiii, June, 1914) uses various methods by which to gain access to the elbow-joint for the treatment of strictly localized disease (synovial tags; floating cartilages; osteochondrolysis; fractures) and has had no trouble from subsequent ankylosis. (1) If the widest possible exposure is required use the posterior transverse incision with division of the olecranon (Trendelenburg). Avoid injuring the ulnar nerve. This method gives the least good functional results.

(2) Anterior median incision along the median nerve. To avoid injuring the nerve branch going to the pronator teres König opened between the pronator and the flexor dig. sublimis and removed a large loose cartilage from in front of the trochlea.

(3) Internal lateral incision separating the flexor muscles from the condyle and retracting them forwards. This gives good access to the inner portion of the joint.

(4) Anterior lateral incision between the supinator radii longus and the brachialis anticus. Retract the musculo-spiral (radial) nerve outwards. Separate the upper capsular attachment. This gives the most clearly defined anatomic access to the joint; through it König removed a traumatic loose cartilage from beside the trochlea and the capitulum humeri.

(5) External lateral incision (humero-radial incision). Separate the upper capsular attachment to the external condyle. This gives excellent access to the most common site of osteochondrolysis and synovial tags. Through this inci-

sion it is also easy to resect the head of the radius or even to excise the elbow-joint.

Arthrodesis.—Occasionally after very extensive removal of bone in excision of the elbow a flail-joint results. If exercises, etc., or the use of some supporting apparatus do not lead to tolerable results, it becomes necessary to operate. The operation is practically that for ununited fracture and requires no special description. The endeavor must be to obtain bony union with the elbow flexed to such an angle that the fingers may be brought up to or nearly up to the mouth. In cases of paralysis when the most careful treatment has failed, and when no hope exists of obtaining a useful joint by means of tendon transplantation or of nerve anastomosis, it becomes necessary to operate for the relief of the resultant and useless flail-joint. The joint must be exposed as in excision; a thin shell of bone must be removed from the humerus and the forearm bones; the sawn surfaces must be brought into good apposition and kept there until bony union has taken place. Of course care must be taken to insure a useful position of the elbow.

FIG. 1319.—R. Jones' arthrodesis.

Robert Jones does *not* consider the hip, wrist, and elbow-joints fitted for bony fixation. In that uncommon type of paralysis in which the muscles of the hand are acting, but the shoulder and elbow are flail, it is necessary to fix the arm in acute flexion so that the functioning hand may be of use. Jones does this "by the excision of the skin flaps, fixing the forearm to the arm, which is infinitely preferable to an arthrodesis of the elbow."

Jones' Operation.—*Step* 1.—At the junction of the middle and lower thirds of the anterior surface of the upper arm choose the point A (Fig. 1319). At the junction of the middle and upper thirds of the forearm choose the point B. Between A and B remove a diamond-shaped area of skin A B C D.

Step 2.—Attend to hemostasis. With sutures unite the raw surface A C D to the raw surface B C D in such a fashion that A is united to B and the cut edge A C to C B, etc. Apply dressings. Use a sling for some months, *i.e.*, until contraction is well advanced.

CHAPTER XCVI

IRREDUCIBLE DISLOCATION OF THE ELBOW

The common causes which impede reposition of a dislocated elbow-joint are: (1) Fragments of bone separated from the articular ends. (2) Contraction and malposition of torn portions of capsule and ligament. (3) Organization of blood-clot. (4) The filling up and obliteration of the olecranon and coronoid fossæ. When sufficiently good results cannot be obtained by means of non-operative treatment, operation is generally justifiable. The operation of choice is "Operative Reposition;" if this proves impossible or inadvisable, it is easy to proceed to excise and interpose a flap of fat and fascia between the divided bones.

Operative Reposition.—Bunge ("Archiv für klin. Chir.," lx, 557) gives an excellent account of the operation as practised in von Eiselberg's clinic. The following is based largely on Bunge's article:

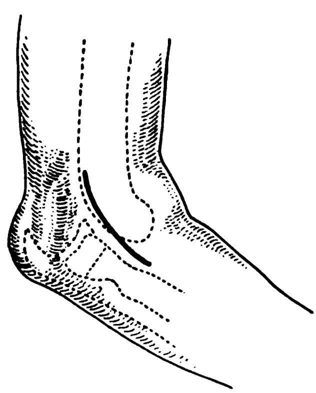


FIG. 1320.—Dislocation of elbow.

Apply an elastic constrictor. On the outer side of the elbow-joint make an incision about 4 inches in length (Fig. 1320). This cut in part of its course lies between the extensor carpi radialis longior and the extensor communis digitorum. Expose the dislocated head of the radius and lateral part of the humerus. Divide all tense bands of scar tissue and, subperiosteally, lay bare the whole upper end of the radius and the outer side of the humerus *at least* as far as the origin of the joint capsule. This is done with scissors and periosteal elevator. Through the above incision inspect the condition of the olecranon and coronoid fossæ and the articular end of the ulna. Remove all abnormal masses of tissue until the fossæ are clear and the normal configuration is displayed. Carefully hunt for and remove any displaced fragments of bone. The articular ends of the bone can now, occasionally, be luxated through the wound; the median side of the joint cleared of scar tissue and the soft parts separated from the humerus and ulna in the same manner as already described.

Replace the bones. Test the mobility of the joint. If movement seems to be at all impeded, make a longitudinal incision about 4 inches in length along the inner side of the joint. Remember the location of the ulnar nerve and avoid injuring it. The cut is made a little in front of the internal epicondyle. Through this wound subperiosteally separate the soft parts from the bones until the

motion is obtained. Remove the tourniquet and attend to hemostasis with the most minute care. This is of extreme importance, as the occurrence of a hematoma interferes with the after-treatment. The articular capsule, the covering soft parts, and the skin are each *separately* sutured with catgut. Dress and put up in a starch bandage strengthened by strips of pasteboard or wire netting. The joint is to be fixed at an obtuse angle and fully pronated.

After-treatment.—The sooner the after-treatment is begun, the better the result will be. As early as the third or fifth day begin making daily passive movements. As soon as the wound has healed the movements must be supplemented by massage and warm baths to the arm. At an early date some form of pendulum apparatus may be used (sand-bag fixed to the wrist) as a means of exerting continuous passive motion. Active movements should be begun early.

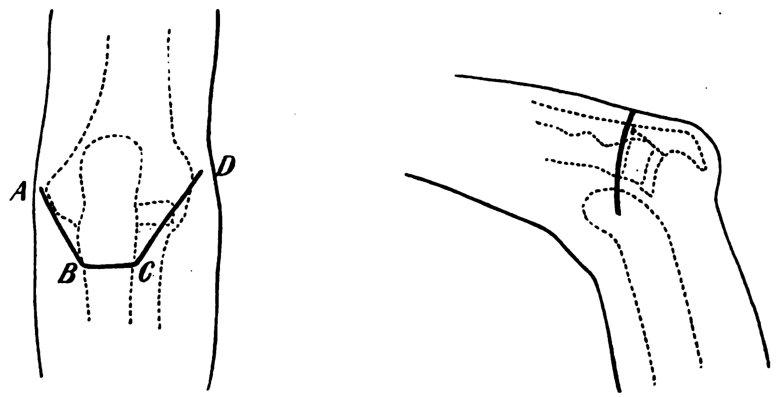


FIG. 1321. FIG. 1322.

FIG. 1321 AND 1322. Schlange's operation.

If any signs of inflammation appear, restrict or stop all exercises until danger has passed. If a hematoma forms, it must be emptied at once.

Schlange considers that the hindrance to reduction is usually a fracture of the articular end of the humerus which has not been properly corrected or in which there is an excess of callus. He operates as follows:

1. Make an incision, on each side, from the points of the epicondyles downwards, inwards and backwards to the ulna about 1 inch below the base of the olecranon. Unite these converging incisions by a transverse cut across the back of the ulna (Fig. 1321). Remember the location of and protect the ulnar nerve. The more or less horseshoe-shaped incision described penetrates to the bone.

2. With a saw introduced through the transverse portion of the incision divide the ulna obliquely upwards and forwards so as to separate the olecranon process and a wedge-shaped portion of the shaft from the ulna (Fig. 1322).

3. Reflect upwards the flap of skin, triceps tendon, and bone, and thus freely expose the whole interior of the joint.

4. Remove any excessive callus and correct any defect which interferes with reduction. Reduce the dislocation.

5. Replace the osteoplastic flap. Unite the sawn surfaces of the ulna by means of a nail which penetrates the skin and thus can be subsequently removed. Suture the periosteum. Close the wound. Dress. Immobilize with the elbow extended. Remove the nail from the bone in about ten days. Begin passive motion early (Schlange, "Archiv für klin. Chir.," lxxxi, Part II).

The head of the radius may be dislocated forwards, the ulna remaining *in situ,* and the remains of the orbicular ligament may be so placed between the bones that reduction becomes impossible; under these circumstances operation may be necessary. Open the joint by Kocher's external incision (see p. 1130). Pick up the torn ends of the orbicular ligament. Reduce the dislocation. Repair the ligaments by means of sutures. Close the wound. Apply dressings.

CHAPTER XCVII

ANCHYLOSIS ELBOW

Anchylosis of Elbow.—The treatment of fibrous anchylosis consists in breaking down the adhesions, under an anesthetic, and in keeping them from reforming by means of proper passive and active exercises. Occasionally in very stubborn cases it may be necessary to operate in the same manner as for osseous anchylosis. When osseous anchylosis is present treatment may or may not be necessary. If the elbow is fixed at such an angle that the patient gets fair use of the limb and if elbow immobility does not, for the individual affected, entail much disability, then no treatment is demanded. If, however, owing to faulty position plus immobility, there is distinct disability, operation is indicated. Until recently the operative treatment was principally directed against the faulty position rather than against the immobility.

This treatment consisted in ordinary excision which was made very extensive if the endeavor was to obtain motion. Thanks to hints thrown out by Verneuil (in 1863), Ollier, Helferich, Rochet, etc., Nélaton (in 1902) proposed a general method of treatment of bony anchylosis by interposition of flaps of muscle. J. B. Murphy (in 1904) showed that fat and fibrous tissue was more suitable than muscle for this purpose as it is from such tissue that the synovialis is originally formed. For bony anchylosis of the elbow it is no longer essential to make a very extensive resection; it is only necessary to remove enough bone to permit of free motion *after* the sawn surfaces have been recovered with a proper flap of muscle or fascia *and* after the wounds in the soft parts have been closed.

Method A.—The author devised and successfully used the following method: Render the limb bloodless. Apply an elastic constrictor.

1. To the outer side of the middle line make a vertical incision from a point 2 inches above to one 3 inches below the tip of the olecranon.

2. Reflect outwards, by dissecting against the bone, all the soft parts external to the incision, laying bare the outer edge of the lower end of the humerus and the outer side of the olecranon, but leaving the annular ligament, if possible, intact. Do the same on the inner side of the wound. Remember the ulnar nerve.

3. With an osteotome separate the olecranon from the humerus. Remove most of the olecranon. Divide the bony tissue uniting the humerus to the ulna and radius. Completely divide the lateral ligaments. Flex the elbow acutely. With the Gigli wire saw remove a small portion of the lower end of the humerus. Remove the articular surface of the ulna and model a new sigmoid cavity. If necessary, remove part of the head of the radius. Divide any bony tissue uniting the radius to the ulna, if possible preserving part or all of the annular ligament.

Smooth and properly shape the opposing surfaces of the radius and ulna. It is usually easy to find enough soft structures (fat, fascia, muscle) to interpose between the radius and ulna where they normally articulate without formally fashioning a flap for the purpose. Trim the edges of the sawn surface of the humerus.

4. Remove the elastic constrictor. Attend to hemostasis. Pack the deep wound with hot gauze. Replace the soft parts in position over the gauze.

5. On the outer side of the original wound reflect the skin from the fat and deep fascia for a great distance (Fig. 1323). Outline and dissect up a flap having its pedicle above the joint-line. The flap consists of fat, fascia, and some of the superficial fibres of the subjacent muscles (Fig. 1323) (anconeus, ext. carpi ulnaris, etc.), and must be large enough to completely cover the lower end of the humerus and 1 inch of its anterior and posterior surface.

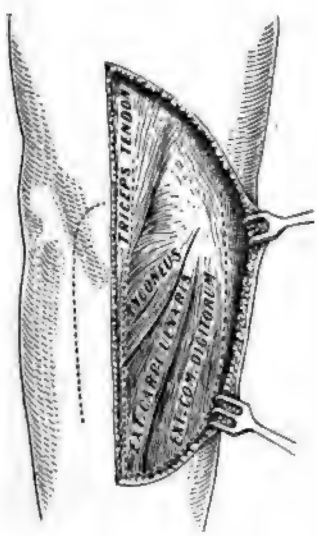


FIG. 1323.—Arthroplasty, author's method.

6. Remove the pack from the deep wound. Wrap the flap over the lower end of the humerus, fixing it with a few stitches of fine catgut.

7. Flex the arm to about a right angle. Replace the tissues as well as possible into their normal positions. Most of the triceps tendon is intact (on the inner side of the original wound) and continuous with the periosteum of the ulna. Close the deep wound with catgut sutures. Provide drainage (rubber tissue). Close the skin wound. Dress. Apply a right-angled anterior splint. After-treatment: Remove the drain in about twenty-four hours. Begin motion in about eight days.

Method B.—Expose the joint as in Method A.

2. Rupture of the Anchylosis.*—First try to rupture the anchylosis by manual force. If this fails, introduce a rugine between the olecranon and the humerus as a lever or, better, divide the olecranon near its base, and after having cut the fibrous bands uniting the humerus to the forearm bones, once more try to break the anchylosis by manual force.

If, as is rare, the above means fail, one must separate the bones with chisel and mallet.

3. Divide the humerus at a point where its diameter begins to diminish (Fig. 1324). Fashion the sawn surface so that it is convex from before backwards.

4. Resect the olecranon at its base. Fashion the bone as shown in Figs. 1325 and 1326. Resect that portion of the head of the radius which projects above the sawn surface of the ulna. If anchylosis exists between the radius and ulna separate these bones with a fine chisel.

* The description of this and the following method is based on Huguier's Traitement des Ankyloses.

5. Remove the elastic constrictor. Attend to hemostasis with unusual care.

6. **Interposition of Muscle.**—(*a*) Flex the forearm acutely. Divide the anterior articular capsule transversely at its ulnar insertion; continue this incision into the brachialis anticus, so as to form the muscular flap (Fig. 1326) (Quénu). With the flap cover the sawn surface of the humerus. The rest of the operation is as in Method A.

(*b*) Berger obtains the muscular flap from the anconeus. Figure 1327 sufficiently explains the operation.

Method C.—Lateral Incisions (Ombrédanne).—Make a 5-inch vertical incision on the inner side of the elbow. Isolate and protect the ulnar nerve. Denude the epitrochlea. Divide the lateral ligament. Denude the anterior surface of the humerus. On the outer side of the elbow make a vertical incision

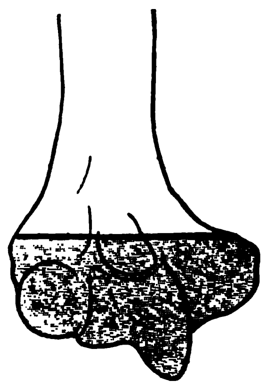


FIG. 1324.—(*Huguier.*)

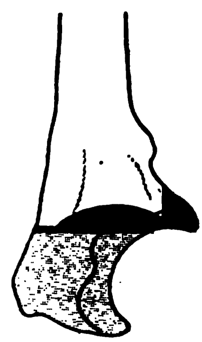


FIG. 1325.—(*Huguier.*)

downwards from a point 2½ inches above the joint-line. If it is necessary to carry this cut more than 1½ inches below the joint-line it ought to incline backwards so as to avoid injury to the radial nerve. Denude the epicondyle with a knife, the anterior surface of the condyle with a rugine. Divide the external lateral ligament. Rupture the anchylosis as already described. Make the lower end of the humerus protrude through the internal wound and divide it transversely immediately below its lateral tuberosities. Figure 1328, in conjunction with what has already been written, sufficiently describes the remainder of the operation.

Transplantation of Cartilage in the Treatment of Anchylosis.—Weglowski's operation ("Zentralblatt für Chir.," 1907, No. 17). This operation has been performed successfully by Weglowski and by Diakonow in bony anchylosis of the elbow.

Step 1.—Expose the elbow. Remove all excess of bone. Model the ends of the bone so as to form proper articular surfaces.

Step 2.—Expose the cartilage of the sixth and seventh ribs and from them remove two plates of cartilage with perichondrium the full length and width of the costal cartilage and about one-half its thickness.

Step 3.—Place these strips of cartilage between the new-formed articular surfaces of the elbow. The strip laid against the articular surface of the humerus must have its perichondrial surface directed towards that bone. It is unnecessary to fix the cartilage in position with sutures.

Step 4.—Close the wound. Immobilize. After ten days begin active and passive motion. In both cases the result was good. One patient died of pleuro-pneumonia five weeks after operation, thus giving opportunity for anatomical examination which showed that the transplanted cartilage lived and was adapting itself satisfactorily to its new surroundings and functions.

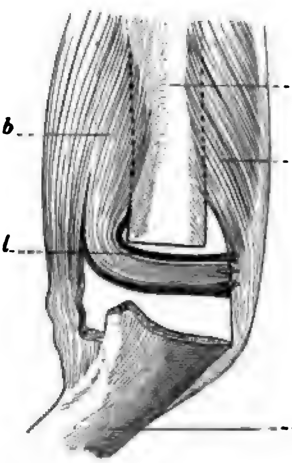


FIG. 1326.—Arthroplasty. (*Huguier.*)
b, Brachialis anticus; *h*, humerus; *c*, ulna; *t*, triceps; *l*, anterior ligament turned in with flap

Bony Anchylosis Elbow.—Buchmann's Operation.—Transplantation of an Entire Joint.—P. Buchmann has operated as follows in two cases of bony anchylosis of the elbow ("Zentralblatt für Chir.," 1908, No. 19).

Step 1.—Make a posterior longitudinal incision down to the triceps tendon and the olecranon. At the outer side of the olecranon divide all soft parts longitudinally. With an elevator separate and push inwards the triceps tendon, remnants of capsule, and the periosteum.

Step 2.—Divide the olecranon at the level of the joint. Divide the lateral remnants of capsule. Divide the bony union between the humerus, ulna and radius.

Step 3.—Flex the elbow. From the trochlea cut out a niche, wider in front than behind and narrower above than below. Remove a very thin slice from the lower end of the humerus.

Step 4.—Separate the brachialis anticus from its insertion into the coronoid process. Cut a quadrangular niche in the ulnar epiphysis (Figs. 1329, 1330). Remove the head of the radius and separate the radius from the ulna.

Step 5.—Excise the first metatarso-phalangeal articulation without opening

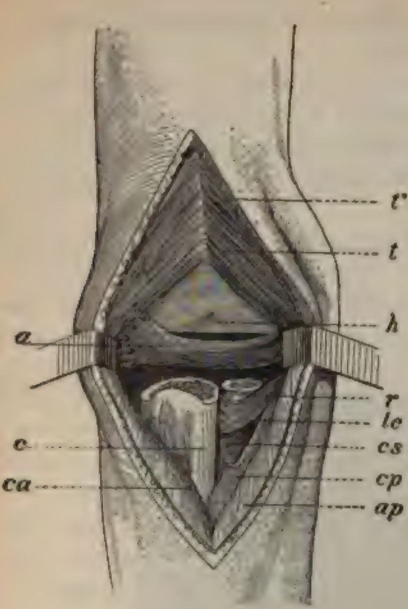


FIG. 1327.

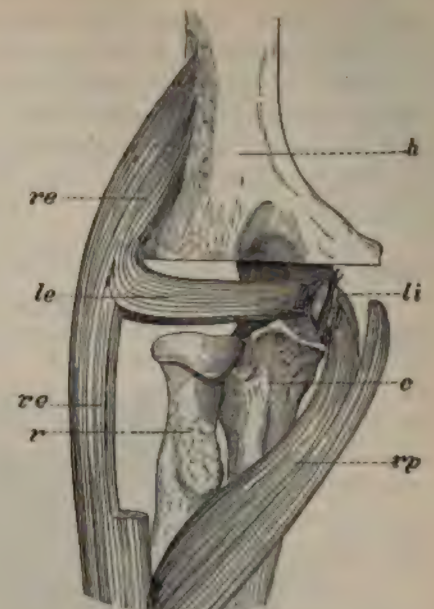


FIG. 1328.

FIGS. 1327 AND 1328.—Arhtroplasty. (*Huguier.*)

FIG. 1327.—*a*, Anconeus interposed; *r*, radius; *c*, ulna; *lc*, flap of ext. ulnaris; *cp*, interposed; *t*, triceps; *t'*, tendon triceps; *ca*, flexor ulnaris; *cs*, supinator brevis; *ap*, aponeurosis.

FIG. 1328.—*h*, Humerus; *c*, ulna; *le*, external muscle flap; *li*, internal muscle flap; *r*, radius; *re*, extensor carpi. radialis longior.

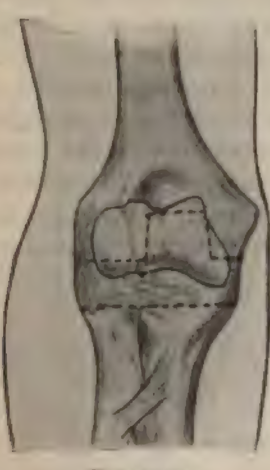


FIG. 1329.

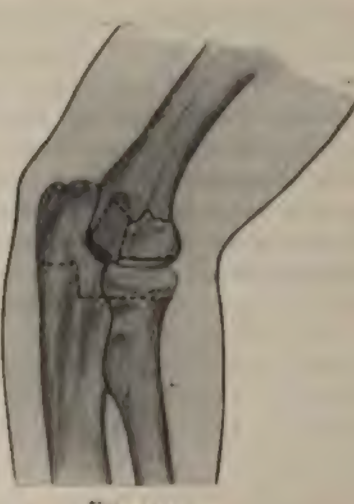


FIG. 1330.

FIGS. 1329 AND 1330.—Buchmann's transplantation of joint. (*Buchmann.*)

the joint itself. Remove with the joint sufficient metatarsus and phalanx to fit into the niches cut in the humerus and ulna.

Step 6.—Implant the excised joint into the wound at the elbow in such a manner that its plantar surface faces backwards. Fit the end of the metatarsus and the phalanx into the corresponding niches cut in the humerus and ulna.

Step 7.—Close the elbow wound and immobilize in the extended position. Close the wound in the foot.

Figure 1331 shows a skiagram of one of Buchmann's cases ten and one-half weeks after the operation.

Myositis Ossificans Traumatica.—Occasionally as a result of injury bone develops inside a muscle. Examples of such lesions are "drill bone," "rider's

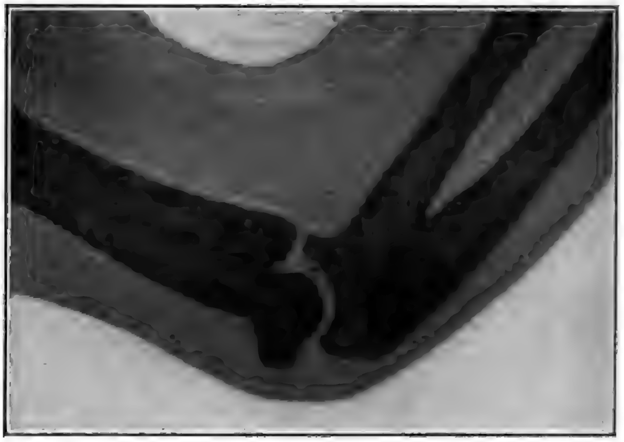


FIG. 1331.—Result of transplantation joint. (*Buchmann.*)

bone," etc. Probably the commonest site of the trouble is the brachialis anticus muscle. Operative treatment consists in exposing the bone through a suitable incision and excising it. No precise description is necessary.

Auvray writes ("La Presse Med.," July 3, 1912) concerning osteomata situated in muscle but unattached to the bone: "it is certain that their extirpation is only exceptionally followed by recurrence (in 92 cases collected by Chabrol there were 75 cures, 15 improvements and only 2 failures). On the other hand, when the osteomata are consecutive to articular traumata, recurrence is much more frequent and the results of treatment much less satisfactory (in 23 cases, 7 cures, 7 improvements, 9 failures)."

CHAPTER XCVIII

WRIST

Anatomically, the wrist-joint is formed between the radius and the triangular ibro-cartilage above and the first row of carpal bones below. Below the ana-:omical wrist-joint there are the carpal and the carpo-metacarpal joints. These ioints are surrounded by many ligaments. Surgically, the series of joints and ›ones between the radius and the metacarpal bones may be considered as one ›tructure, completely surrounded by one periosteo-ligamentous investment, an nvestment which is here thicker, there thinner; here more firmly, there less irmly united to its contents. Numerous tendons pass over or are inserted into :his ligamentous investment, so that if the latter is separated from its contained ›ones the tendons also are separated or raised from them without being injured.

Typical Subperiosteal Resection of the Wrist.—Ollier's Operation.

Step 1.—**Incision through the Skin and Ligamentous Investment.**—Note :he position of the styloid processes of radius and ulna and imagine a line join-ng these two joints (interstyloid line). Note the tendon of the *extensor indicis*, ›r if this cannot be made out, the base of the second metacarpal bone.

Beginning at the middle of the dorsal aspect of the second metacarpal bone, nake an incision upwards and inwards a little to the radial side and following .he line of the tendon of the extensor indicis (Fig. 1332). This oblique incision 'eaches the middle point of the interstyloid line where its direction is changed :o that of the axis of the forearm.

Recognize and retract inwards the tendon of the extensor indicis, without ›pening its sheath. This exposes the insertion of the extensor carpi radialis ›revior. Incise the periosteum of the head of the third metacarpal to the inner ide of the insertion of the extensor carpi radialis brevior. Continue the peri-›steal incision upwards, dividing the joint capsule and the posterior annular igament between the extensor indicis and the long extensor of the thumb.

On the ulnar side of the wrist make an incision from a point 1¼ inches .bove the point of the ulnar styloid process to a point ¾ inch above the base ›f the fifth metacarpal bone. The incision is to the inner side of the extensor :arpi ulnaris, and is carried directly to the bone.

Step 2.—**Removal of the Carpal Bones.**—Through either the dorsal or ulnar ncision separate the ligamentous investment from the underlying structures, eize the individual bones in forceps and dissect them out. If the ligamentous nvestment is properly separated, the tendinous insertions will be preserved .nd the least possible amount of damage inflicted. The pisiform bone may or nay not be removed. The unciform process may be divided while its bone › being removed and if not diseased it may be left *in situ*.

Step 3.—After the removal of the carpal bones it is easy to resect the lower end of the radius and ulna and to remove the triangular cartilage. The carpal ends of the metacarpal bones are readily excised with rongeur forceps.

Step 4.—Review the whole wound and excise with forceps and scissors any diseased tissue. Unite by suture the divided annular ligament. In cases of tuberculosis rub the wound cavity with iodoform. Provide tubular drainage. Close the wounds with sutures. Some surgeons pack the wound with iodoform gauze and suture after the lapse of a few days, or they apply, but do not tie, the sutures on the completion of the operation, pack with gauze, remove the pack

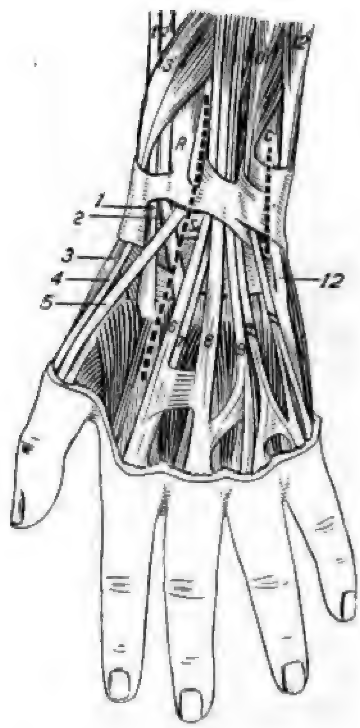


FIG. 1332.—Ollier's operation. (*After Farabeuf.*)

R', Radius; *C*, ulna; *Sc.*, scaphoid; *t*, trapezoid; 1-1', tendon ext. carpi radialis long.; 2-2', ext. carpi radialis brevior; 3-3', ext. ossis metacarpi pollicis; 4-4', ext. brevis pollicis; 5-5', ext. longus pollicis; 6-8-9-10, ext. communis; 7-7', ext. indicis; 11-11', ext. minim. dig.; 12-12', ext. carpi ulnaris.

after a few days, and tie the sutures already in place. Instead of the above dressings the wound may be filled with iodoform or bismuth paste and closed with or without drainage. After the dressings have been applied the member must be fixed with the hand in a position of dorsal flexion. Various special splints have been devised for this purpose. The author uses a plain anterior splint of wood, reaching from near the elbow to the roots of the fingers. The necessary dorsal flexion is obtained by means of padding, and the whole is kept in place by starch bandages. Possibly a better means of fixation is plaster of Paris, strengthened by a wide strip of tin imbedded in the plaster on the ante-

rior surface of the arm, and bent to give the requisite amount of flexion. Whatever means of immobilization is adopted, the fingers and thumb must be left uncovered so that they may be exercised as early as possible.

After-treatment.—At the earliest date possible practise passive motion of the fingers and thumb. The patient should be encouraged to do this himself. Active movements of the fingers and thumb must be early attempted and the patient told to make "piano-playing" movements. All these movements are of extreme importance so that fibrous union of the tendons may be avoided. The limb must be kept immobilized until the wrist has solidified considerably. This may take six months or even longer. When the wound is healed a light splint, *e.g.*, Ollier's wire splint or some leather device, should replace the original plaster or starch bandages. The extensor and flexor muscles of the wrist should be kept in "condition" by applications of electricity. The splint should be removed several times daily and passive movements of the wrist practised. Much patience is required before a good result can be obtained.

FIG. 1333.—Taylor's operation. (*Taylor.*)

The operation is usually performed for tuberculous disease. Müller has excised the wrist in arthritis deformans with good results. In one case of arthritis deformans the author obtained a result which was only fair, but this he thinks partially due to want of completeness in the operation done.

Wm. J. Taylor's Operation ("Annals of Surgery," xxxii, 360).—This is a modification of an operation suggested by Studsgaat and carried out by Mynter.

Apply an elastic constrictor above the elbow.

Step 1.—Make a longitudinal dorsal incision from the lower end of the radius downwards along the line corresponding to the space between the second and third metacarpal bones (Fig. 1333). Through this incision penetrate between the metacarpal bones to their palmar surface, but be careful *not* to injure the soft tissues of the palm. (Mynter made a small palmar as well as a long dorsal incision.) Split the carpal bones. This splitting is easy, as, when operation is required because of tuberculosis, the bones affected are softened or destroyed by the disease.

Step 2.—Remove all diseased tissue. Clean thoroughly. Lessen the size of the deep wound by means of a few sutures. Loosely pack with gauze. Partially close the skin wound. Dress. Apply a suitable splint.

Bardenheuer's Operation.—Through a suitable incision remove the carpus *en masse.* If possible, preserve the trapezius so as to retain the mobility of the thumb. Obliterate the head space left by the removal of the carpus in the following manner: Divide the three middle metacarpal bones so as to form a wedge whose apex is formed by the third metacarpal. Fashion the forearm bones so as to form a V-shaped surface and into this V place the metacarpal wedge. Nail the third metacarpal to the radius, the fifth metacarpal to the ulna, and the trapezius to the outside of the radius. Any tendons which have been resected because of involvement in the disease are now reunited by suture.

Atypical Resection of the Wrist.—In tuberculosis, limited foci of disease may be safely reached through small incisions on any part of the dorsum of the wrist, if care is taken to avoid division of tendons. In more advanced carpal disease access may be obtained through Ollier's incisions and the affected structures removed with the sharp spoon, forceps, and scissors. After such operations the wounds are carefully cleaned, iodoformized and either packed with iodoform gauze or closed by suture after drainage is provided.

CHAPTER XCIX

WRIST ANCHYLOSIS

1 A.—Nélatons' Operation. ("Rev. d'orthopedie," 1905, Nélaton; nt des Ankyloses," Huguier).

ose the wrist-joint by a longitudinal incision along the radial side nsor tendons of the index finger. Extend the incision upwards so as xpose the lower portion of the extensor communis digitorum. Re- xtensors of the thumb outwards, those of the fingers inwards.

ık down the anchylosis by manipulation or with the chisel. Excise w of carpal bones, except the pisiform. Resect sufficient of the second es in a curve, to give them the shape of a condyle.

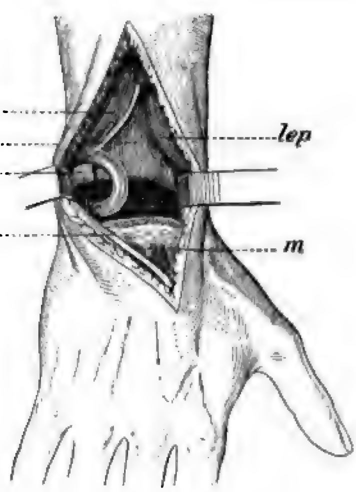


FIG. 1334.—Arthroplasty. (*Huguier.*)
ius; *c*, ulna; *m*, metacarpus; *exc.*, ext. communis digitorum; *t*, tendon ext. indicis; *lep*, ext. long pollicis.

n the outer side of the fleshy body of the extensor communis digitorum having its pedicle below. The flap must be about ½ inch wide s long. Place the flap transversely in the gutter formed by the re- he carpus and fix its end to the fibrous tissue at the inner side of the 1334).

› all bleeding. Close the wound after providing for drainage. After begin motion. Nélaton operated successfully in this fashion in a :hylosis from arthritis.

1 B.—The author suggests the following method as simpler and at

least as efficacious as Nélaton's; it is almost identical with an operation for anchylosis of the first carpo-metacarpal joint which he performed successfully.

1. Expose the wrist-joint by a longitudinal incision along the radial side of the extensor of the index finger. Divide the skin, fascia, etc., so as to open the joint. Do not cut the fascia upwards any farther than is absolutely necessary. Break down the anchylosis and excise bone from the carpus to the extent necessary for free motion, as in Nélaton's operation.

2. Extend the original incision upwards *dividing the skin alone* (Fig. 1335). Expose a large surface of the fascia of the forearm. From the fascia dissect

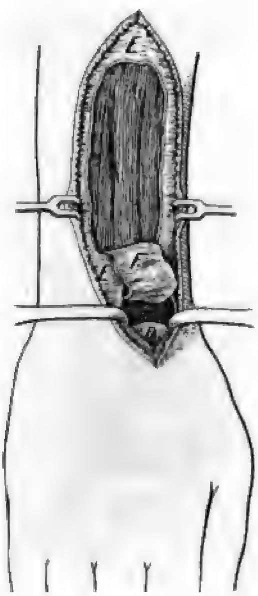


FIG. 1335.—Arthroplasty.
E, Deep fascia; *F*, flap of fascia; *D*, carpal bones.

downwards a flap of fascia, fat, and a few muscle fibres (pedicle below and sufficiently above or to the side of the opening made in the fascia for the arthrectomy to permit of good nutrition).

3. Turn the flap of fascia downwards, tuck it into the deep wound so that it completely envelops the articular surface of the radius. Fix the flap in position with fine catgut sutures.

4. Close the wound after providing for drainage. Apply dressings and a splint. Remove the drain in twenty-four to forty-eight hours. Begin motion as soon as the wound is healed.

CHAPTER C

METACARPO-PHALANGEAL DISLOCATIONS

Dorsal dislocations of the first metacarpo-phalangeal joint are occasionally irreducible by manipulation and demand operation. Stimson (Fractures and Dislocations, p. 707) writes: "The cause of this difficulty, in all the cases in which I have exposed the joint, has been the torn edge of the anterior ligament closely drawn across the back of the metacarpal behind its head, and a slight nicking of that edge made reduction easy."

The Operation.—Make a longitudinal incision over the palmar surface of the prominent head of the metacarpus. As soon as the head is exposed, retract the edges of the wound and note that the anterior ligament (capsule) has been torn from its metacarpal insertion and its edge can be seen above it and close to the phalanx. Longitudinally divide or nick the capsule, and reduction becomes easy.

Frequently the capsule curls tightly over the articular surface of the phalanx in this condition. The nicking of the capsule makes it easy to pull the offending membrane out of its false position by means of hooks. Close the wound in the capsule with fine catgut. Close the skin wound. Dress. Begin movements in about one week.

In cases of old unreduced dislocations of one or other of the metacarpo-phalangeal joints, Friedrich recommends resection of the head of the metacarpus, but gives warning that pain on motion may persist for a long time.

CHAPTER CI

SYNDACTYLISM. WEBBED FINGERS

The easiest way in which to operate for webbed fingers is merely to divide the web and suture the resulting wounds. Unfortunately there always results a contraction of the wound near the root of the fingers and the condition recurs to a large extent. The following are the principal operations devised to prevent recurrence:

I. Perforate the web at its apex. Through the perforation pass a stout silver wire. Keep the wire *in situ* until the perforation is thoroughly healed when the rest of the web may be divided and the wounds sutured.

II. On the dorsal surface of the web make the triangular incision A B C (Fig. 1336) and reflect the flap A C D, which should be thick and well nourished. Divide the web uniting the fingers. Turn the flap A C D between the divided fingers and suture the apex D of the flap to the palmar side. Either suture the

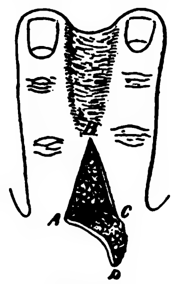


FIG. 1336.

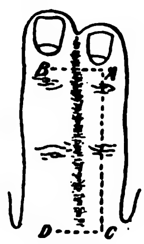


FIG. 1337.

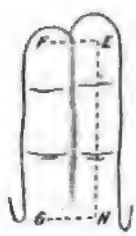


FIG. 1338.

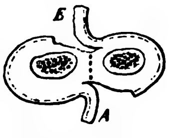


FIG. 1339.

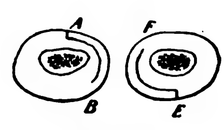


FIG. 1340.

FIGS. 1336 TO 1340.—Syndactylism.

wounds caused by the division of the web or bring them together with adhesive strips and dress with an ointment containing Scharlach red. Schreiber ("Zentralblatt für Chir.," 1910, No. 29) claims much for this operation.

III. **Didot's operation.**

Step 1.—On the dorsum of the fingers and web make the incisions B A C D (Fig. 1337) and reflect the flap outlined.

Step 2.—On the palmar aspect make the incision F E H G (Fig. 1338) and reflect the flap outlined.

Step 3.—Divide the rest of the web.

Step 4.—Make the flap B A C D envelop the finger to which it is attached (Fig. 1339) and suture it in place. Similarly envelop the other finger with the flap F E H G. Figs. 1339 and 1340 are self-explanatory.

CHAPTER CII

OPERATIONS ON THE TENDONS OF THE FINGERS

Occasionally after a finger is flexed until its tip touches the palm it can only be extended by a considerable muscular effort or by the aid of the other hand. "In overcoming the hitch by the action of the extensor muscles the finger springs back suddenly and usually with more or less pain." The cause of the trouble

FIG. 1341. Needle in tendon. Payer's case.

FIG. 1342. Split tendon. Haegler's case.

FIGS. 1341 AND 1342.—Snapping fingers. (*Weir.*)

is either an enlargement or nodulation of the tendon or a narrowing of the tendon sheath. When trauma is the exciting cause, the lesion is usually found in the fingers; in other cases the obstruction is almost always in the short space between the digito-palmar fold and the first fold or wrinkle of the palm. If

the trouble does not soon disappear under bloodless treatment and if it is very annoying or disabling, operation is indicated. The principle of operation is free exposure, removal or repair of any vertical evident lesion (Figs. 1341, 1342, 1343, 1344), and closure of the wound.

FIG. 1343.—(*Weir.*)
Tumor causing trigger finger.

FIG. 1344.—(*Weir.*)
Enlargement deep flexor.

FIG. 1345.—(*Weir from Spalteholz.*)

When, as is commonly the case, there is a fusiform swelling of the tendon or merely a thickened sheath, Weir recommends that the sheath be split (Fig. 1345) and left open, the superficial wound being closed (Weir, "Journ, A. M. A," Oct. 5, 1907).

Abbé considers "snapping finger" to be due to a crumpling up of the conoined flexor tendon by a transverse band of fascia situated beneath the distal lexure crease of the palm. A longitudinal incision, about ½ inch long, through he fascia at the flexure crease is sufficient to cure in some cases.

Tendon Transplantation.—When the flexor tendons of one or more fingers ave been destroyed, *e.g.*, by necrosis due to phlegmon, function may be restored y transplantation. This is *one* of the many good things for which E. Lexer s responsible ("Archiv für klin. Chir.," xcviii, Hft. 3).

1. Obtain the graft (*a*) from a suitable tendon in a recently amputated limb N. B.: The researches of Carrel and others show that tissues and organs may e preserved in suitable solutions, *e.g.*, Ringer's, in cold storage for days and then e successfully implanted), (*b*) from a segment of the palmaris brevis, (*c*) from slip cut out of the rectus femoris tendon, the tendo Achillis, or any suitable and onvenient source.

2. Make short incisions in the natural transverse folds at the base of the irst phalanx, in the palm or at the wrist, as may be required to find the stump f the destroyed tendon.

3. Through one of these incisions introduce a strabismus hook and with t find and pick up the desired tendon stump (the flexor profundus). Separate he tendon from acquired adhesions. With a suitable instrument introduced hrough the incision bore a subcutaneous tunnel to the ungual phalanx. From he side or from the tip of the finger cut down upon the end of the tunneling nstrument. This cut *must* be made as a sort of flap as sufficient exposure is ecessary and the wound *must not lie directly over* the implanted graft.

4. Suture one end of the graft to the tendon stump and pull the other end f the graft through the tunnel by means of an eyed probe or a thread. Suture he distal end of the graft to the periosteum of the ungual phalanx or, better, to he vivified bone itself.

5. If it is desired to replace the destroyed superficial flexor at the same time t may be accomplished somewhat similarly as follows: Find the proximal tump of the tendon and suture to it one end of a graft. Split the other end of he graft and conduct each of the two slips of the graft through the tunnel to he middle phalanx. Make a small cut on each side of the middle phalanx preserving vessels and nerves from injury) and through these cuts suture the endon slips one on each side to the phalanx.

6. Close the wound. Apply dressings. Begin movements on the sixth day fter operation. The early motion is imperative, otherwise connective tissue enetrates and substitutes itself for the tendon which becomes a hard, immobile, ibrous mass. Unfortunately fingers requiring tendon transplantation have isually been the seat of severe inflammation and have deposits of scar tissue which in themselves cause deformity and prevent motion. In these cases reliminary operations are necessary. Thorough excision of the scar tissue and lastic repair (by skin flaps, etc.) are absolutely requisite before the tendon translantation may be attempted.

E. Lexer reports the following case: "As the result of injury and suppuration

the hand was severely crippled and entirely useless; the thumb was claw-like, immobile and flexed into the palm due to complete loss of its tendons; an extensive scar above the wrist-joint produced moderate flexion of the fingers which retained a mere trace of motion. It was necessary to resect the ankylosed first metacarpo-phalangeal articulation and produce a pseudarthrosis by the interposition of fat. Then the thumb had to be straightened by means of an H-shaped incision and the resultant defect covered with skin. Three weeks later a segment of tendon was implanted as a substitute for the lost deep flexor. This was accomplished after excision of the scar at the wrist, by tunneling through the sclerosed muscles of the ball of the thumb up to the ungual phalanx, drawing the implant through the tunnel and fixing its end to the phalanx. But as it was impossible to find the flexor tendon of the thumb above the wrist in spite of having separated all the tendons from the scar (it must have been discharged as a sequestrum), I split a slip from the flexor carpi radialis and united this to the implant. Subsequent adhesion of the other flexor tendons was prevented by surrounding and separating them with free (*i.e.*, non-pedunculated) fatty tissue. Although the result was but moderate, it was most satisfactory because of the exceedingly unfavorable condition encountered. The fingers gained one-half of their active function and could be, passively, flexed completely. Best of all the thumb remained straight and could be flexed so that its point could press firmly against the index finger."

CHAPTER CIII

OPERATIONS FOR INFECTIVE LESIONS OF THE HAND

From the standpoint of practical surgery the vast majority of standard works on Anatomy are wofully unsatisfactory in their description of the anatomy of the hand. Poirier and Charpy, in their colossal "Traité d'Anatomie Humaine," give much information regarding the tendon sheaths of the palm, while Allen B. Kanavel deserves much thanks for an encyclopedic article or series of articles on the hand and its infections ("Surg., Gyn., Obstetrics,"

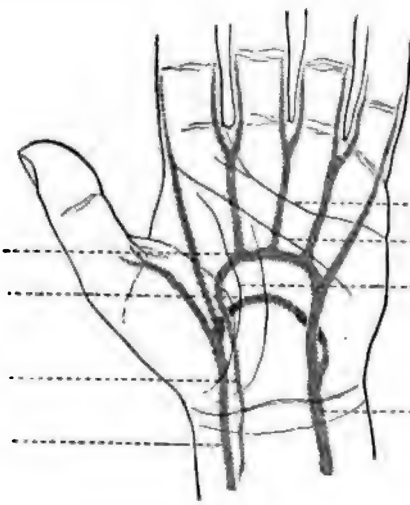


FIG. 1346—(*Morris.*)
Relation of the palmar arches to the folds of the palm.

Sept., 1905; Nov., 1907; Jan., and Feb., 1909; "Infections of the Hand," 1912). These publications are freely used in the preparation of this chapter. In order to operate, with any degree of precision, for the relief of infective lesions of the hand a fair knowledge of anatomy is requisite.

Figure 1346 shows the position of the palmar arches.

Figures 1347, 1348, and 1349 show the usual arrangements of the synovial sheaths of the flexor tendons of the hand and how the sheaths in the fingers do or do not communicate directly with the palmar sheaths or bursæ. The synovial sac surrounding the more internal of the common flexors lies on the ulnar side of the palm and wrist (Fig. 1350). As this sac forms a pouch in front of the superficial flexors, separates the superficial from the deep flexors and forms a pouch behind the deep flexors, it may be considered as consisting of three pouches (pre-, inter-, and retro-tendinous), all opening into a common pouch—

the ulnar or cubital bursa. The importance is evident of recognizing this complicated arrangement when it is necessary to drain pus from the ulnar bursa. The other palmar bursæ are not so complicated.

The synovial sheaths of the extensor tendons about the wrist are comparatively simple (Fig. 1351). Besides the synovial sheaths and bursæ there are certain well-defined, uniform spaces upon the fingers, palm, and dorsum of the hand in which pus can accumulate. A section (Fig. 1352) made through the hand 1⅜ inches (3.5 cm.) proximal to the metacarpo-phalangeal joints shows a number of these spaces admirably, while a section (Fig. 1353) taken a little higher up through the distal part of the thenar area shows another view of these same spaces. Kanavel, in a recapitulation of some of his findings, writes: "We note that we have five great spaces, with their tributaries, in which pus can accumulate.

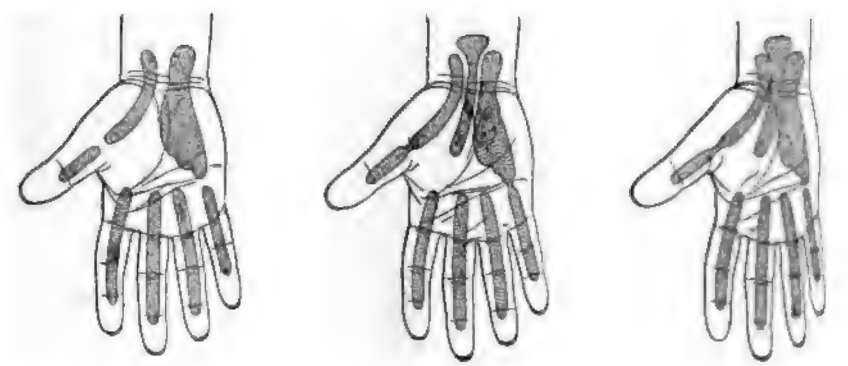


FIG. 1347. FIG. 1348. FIG. 1349.
FIGS. 1347, 1348 AND 1349.—Synovial sheaths of flexors of fingers. (*Poirier and Charpy.*)

"*First*, the dorsal subcutaneous, which is an extensive area of loose tissue, without definite boundaries, allowing pus to spread over the entire dorsum of the hand.

"*Second*, the dorsal subaponeurotic, limited upon its subcutaneous side by the dense tendinous aponeurosis of the extensor tendons, upon the deep side by the metacarpal bones, having the shape of a truncated cone, with the smaller end at the wrist and the broader at the knuckle. Laterally the aponeurotic sheet shades off into the subcutaneous tissue.

"*Third*, the hypothenar area, a distinctly localized space.

"*Fourth*, the thenar space, occupying, approximately, the area of the thenar eminence, to the flexion adduction crease of the thumb, not going to the ulnar side of the middle metacarpal. It should be remembered that this space lies deep in the palm, just above the adductor transversus.

"*Fifth*, the middle palmar space, with its three diverticula below along the lumbrical muscles, limited by the middle metacarpal bone upon the radial side, overlapped by the ulnar bursa upon the ulnar side, and separated from the thenar space by a partition which is very firm everywhere except at the proximal

end, where it is rather thin. A small isthmus can be found leading from the proximal end of the space under the tendons and ulnar bursa at the wrist up into the forearm."

Figures 1354, 1355, and 1356 show the best sites for incisions in infections

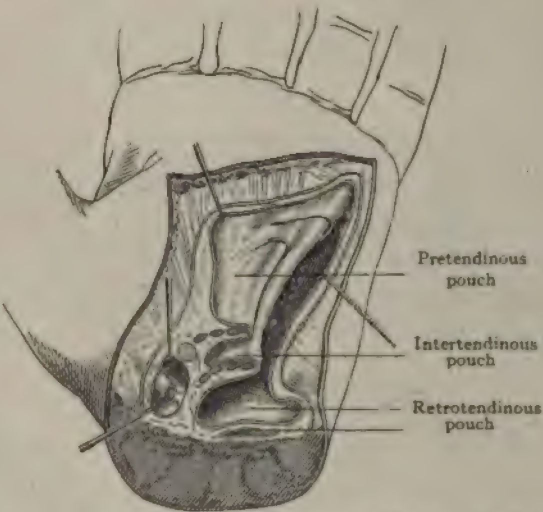


FIG. 1350.—Synovial sheaths of palm. (*Poirier and Charpy.*)

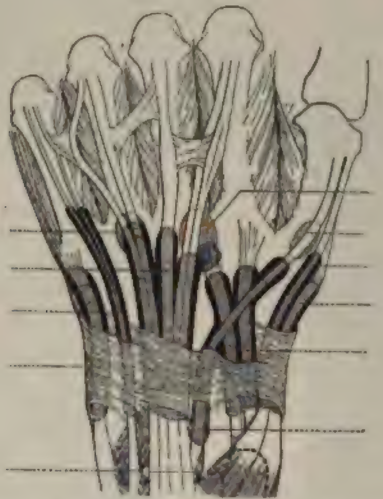


FIG. 1351.—Synovial sheaths of back of hand. (*Poirier and Charpy.*)

of the hand and the best route for securing drainage of the midpalmar and thenar spaces. In any case of extensive or deep suppuration of the hand when operation has been decided on, it is well if possible to administer a general anesthetic, apply an elastic constrictor to the upper arm and operate

deliberately with a precision rendered possible by a knowledge of anatomy and an absence of blood.

After providing for drainage, apply liberal dressings and use Bier's hyperæmia by means of an elastic constrictor. As an alternative one may evacuate the pus by appropriate incisions and apply hyperæmia by Klapp's suction method which has given the author very gratifying results.

Incised wounds of the hand must be treated on ordinary surgical principles; tendons, if divided, must be repaired and cleanliness sought. Many wounds

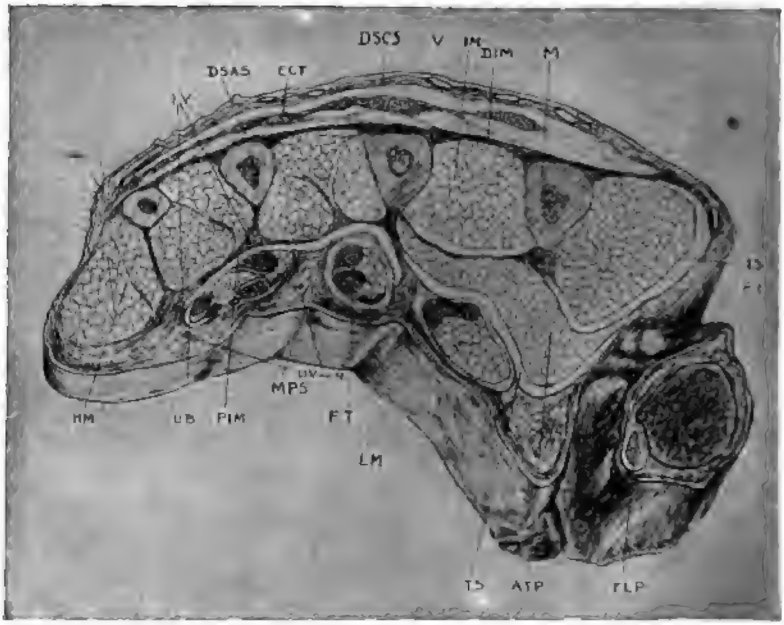


FIG. 1352.—(*Kanavel.*)

Cross section, 3½ cm. proximal to joint. SS, Synovial sheath; DSCS, dorsal subcutaneous space; DSAS, dorsal subaponeurotic space; ECT, extensor communis tendon; FT, flexor tendon; LM, limbrical muscle; IM, interossei muscle; M, metacarpal bone; BV, blood vessels; N, nerves; TS, thenar space; MPS, middle palmar space; ATP, adductor transversus pollicis; DIM, dorsal interosseous membrane; PIM, palmar interosseous membrane; UB, ulnar bursa; IS, space between adductor transversus and first dorsal interosseous; DIM, dorsal interosseous membrane; FLP, flexor longus pollicis in its synovial sheath; HM, hypothenar muscles with intermuscular spaces; IV, interosseous vessels and nerves.

of the hands are very much lacerated and have much dirt ingrained into them. Two methods of treatment are possible: (A) Cleanse as thoroughly as possible, repair injured tendons, close the wound, providing for drainage by means of rubber tissue. If infection develops later, treat it. Bier's hyperæmia is of much value in warding off the consequences of infection. (B) Cleanse the wound as thoroughly as possible. Swab the wound with spirits of turpentine which may act in three ways; (*a*) as a solvent of grease, (*b*) as an antiseptic, (*c*) as an excitant of local leucocytosis. Pack the wound loosely with gauze. Apply abundant moist dressings *loosely*. Apply Bier's constrictor to produce hyperæmia. Immobilize. Immobilization is of special importance to prevent spreading of infection. George Gray (who has unusual experience in the treat-

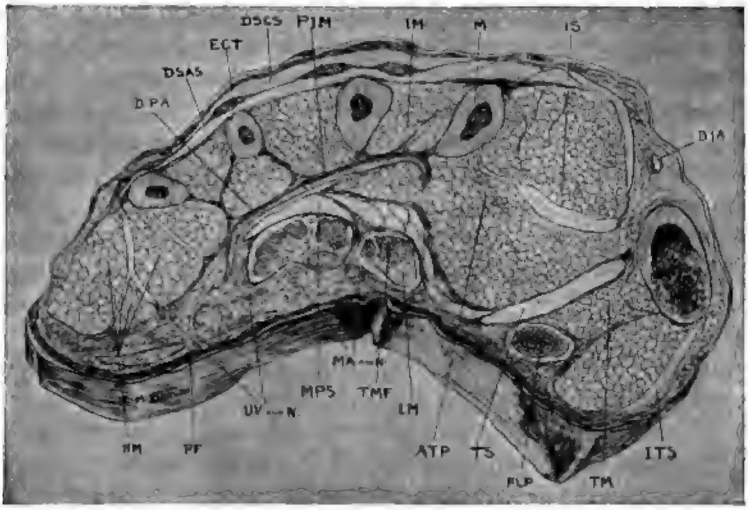


FIG. 1353.—(*Kanavel.*)

Cross section, through distal part of thenar area. See Fig. 1352 for common lettering ITS, indefinite nar spaces; TMF, tendon of middle finger; TM, thenar muscles; PF, palmar fascia; RA, radial artery; A, deep palmar arch—digital branches beginning; DIA, dorsalis indicis artery.

FIG. 1354.

FIG. 1355.

FIGS. 1354 AND 1355.—Sites for incisions. (*Kanavel.*)

ment of filthy lacerated wounds of the hand) treats his patients as above, and after the lapse of about forty-eight hours, if infection has not developed, removes the dressings, repairs injured tissues, and closes the wound, providing for drainage by means of rubber tissue.

Infection has entered through a wound in the finger. Suppuration has taken place. How ought the principles of treatment outlined in the preceding pages be carried out?

Make the first incision at the site of known infection. Open the tendon sheath, if involved, at the side. This applies to the middle and proximal

FIG. 1356.—Drainage of palm. (*Kanavel.*)

phalanges. Do not cut the tissues over an articulation unless it is necessary to drain the joint. If necessary incise on both sides of the finger. If the infection involves the palmar end of the sheath, but has evidently *not* spread farther, incise in the middle line "from the flexion crease at the base of the proximal phalanx for about three-fourths of an inch into the palm. If, however, there is some question whether the lumbrical spaces at the side have begun to be involved the incision is made upon the side most affected, opening the space and the tendon sheath at the same time." When the index finger is affected and the in-

fection has passed into the lumbrical space on the radial side, then it may extend into the thenar space. Under these circumstances incise so as to open the tendon sheath and lumbrical space just external to the tendon—find if pus is present in the thenar space. If pus is present continue the incision parallel to and on the radial side of the metacarpal of the index finger. This cut must run *dorsal* to the web of the thumb. Through the wound push a sinus forceps (hemostat) (Fig. 1356) across the palmar surface of the metacarpal bone into the thenar space. Open the blades of the forceps to enlarge the deep wound. Provide rubber tissue drainage. By the above means the deep palmar space is drained without the palm being incised and without danger to the palmar arches. When introducing the forceps do *not* force its point beyond the middle metacarpal, as it then would penetrate and probably infect the mid-palmar space. When the middle finger is infected and the trouble spreads upwards, the mid-palmar space becomes involved. Incise to the ulnar side of the tendon from the flexion crease at the base of proximal phalanx for about ¾ inch into the palm. If pus can be pressed from the palm into the wound pass a closed sinus forceps, at a deeper level than the tendons, so as to penetrate and provide drainage for the mid-palmar space. It is easy to open the mid-palmar space from the ulnar side of the flexor tendon of the ring finger by pushing a forceps upwards and inwards under the tendons (Fig. 1356).

Of course infection *may* extend from any of the fingers to the palmar synovial sheaths, but is very much more liable to do so from the little finger, whose flexor sheath is continuous with the palmar sheath (ulnar bursa) in 50 per cent. of the cases, or from the thumb (Figs. 1347, 1348, and 1349), whose tendon sheath extends from the *distal* phalanx to the palmar sheath (radial bursa) and above the annular ligament of the wrist in 95 per cent. of the cases. When there is grave infection of the ulnar bursa very free drainage is necessary. The following method (Kanavel's) fulfills the requirements with the minimum of injury to important structures.

Incise at the point of infection and there open the tendon sheath. Press the palm; if it is involved, pus will come into the wound. Incise at the distal flexion crease of the palm and enter the tendon sheath. Pass a director up the sheath into the palm. Guided by the director open the ulnar bursa, cutting to the ulnar side of the tendons. "Having arrived at the anterior annular ligament, pressure above over the prolongation of the sheath in the forearm will force pus downwards into the sheath below the ligament if the infection has extended here, as it generally has. If it is very early in the course, it may be justifiable to leave the anterior annular ligament intact and incise the sheath above the ligament on the same line. This line here lies about one-half inch to the radial side of the ulnar artery. Generally, however, the swelling is such that the pulsation of this vessel cannot be felt. It is then necessary to proceed by choosing a point at the junction of the middle and ulnar thirds of the flexor surface and incising carefully, layer by layer, until the group of flexor tendons is reached. These can be identified by moving the fingers. The dissection is now carried down along the ulnar border of these tendons in juxtaposition to

them and immediately above the anterior annular ligament, since the sheath lies to the ulnar side and posterior to the tendons. If infected it should be freely opened, since the swelling due to œdema and inflammatory infiltration tends to a close small opening. If the infection is now seen to be at all severe, the anterior annular ligament is split as far to the ulnar side as possible. The hook of the unciform interferes somewhat with the incision. If it is determined at first when the palmar part is incised that the infection is at all severe, I proceed differently. The incision is continued from below upwards, at once cutting the anterior ligament and carrying the incision about an inch up on the forearm.

This latter is made as much to drain the subcutaneous area above the wrist, which commonly becomes infected, as to open the sheath. This incision is always supplemented by a transverse drainage above the wrist-joint as follows: At a point about 1½ inches above the tip of the ulna an incision is made directly down on this bone at its flexor surface; an artery forceps is now thrust across the flexor surface of this bone and the radius until it impinges on the skin at the radial side, where the knife cuts down upon it. The incisions in the skin are now enlarged to the length of an inch and a half or more and with the artery forceps, the subtendinous area to the same extent. Especial care should be used here to make the incision neither too far upon the flexor surface nor dorsally, since in the first instance, especially upon the radial side, the artery may be injured either by the primary incision or subsequent necrosis, and in the second instance, if the incision is too far dorsal it will not drain easily. If the primary incision is made low down and on the radial side the danger of injuring the radial is greater. With the proper precaution, no anxiety need be felt (Fig. 1355). Having opened this area the finger is now inserted under the flexor profundus tendons and if there is any infection of the sheath it is bulging and can be opened easily. In case it is not found easily, flexion and extension of the fingers will locate the tendons involved and the palpating finger is pushed up among them, or an artery forceps can be pushed down from the bursa which has been opened in front. Its point is felt plainly by the finger and the opening dilated freely. As a matter of fact, the infection will be found to have ruptured into this space in practically every case, except in the very earliest stages. I wish to emphasize that it is this incision that I depend on for drainage of the upper end of the bursa, since it extends upwards on the tendons on their posterior surface. I have even made it in cases where I had made no incision upon the flexor surface of the forearm, or had deemed it advisable to cut the anterior annular ligament. Particularly in infections of the radial bursa do I do this. In other words, I use it as a site for entering and draining the sheath before rupture as well as the site for incision for draining the extension into the forearm."

When there is grave infecton of the thumb and radial bursa, Kanavel operates as follows: "Here it is my habit to dissect down to the tendon upon the flexor surface of the proximal phalanx; having entered the sheath, the incision is enlarged along the sac through the thenar eminence separating the muscular mass (heads of the flexor brevis pollicis). It should be remembered that the tendon lies nearer the palm than one would be inclined to think, and that the

mass of the thenar muscles lies to the radial side of the incision. This is only carried up to within a thumb's breadth of the lower border of the anterior annular ligament, since I have previously shown by observations made upon cadaver hands, and reported in an earlier contribution, that the motor nerve to the thenar muscles passes across the sheath between this point and the lower edge of the anterior annular ligament, and in my opinion loss of the flexor longus pollicis tendon is to be preferred to destroying this nerve, and thus bringing about a loss of the muscles which it supplies. The incision begins again at the upper part of the anterior annular ligament, opening the proximal end of the radial bursa above this ligament. If the process is severe and there is fear that the sheath may have ruptured, incisions are made laterally above the wrist-joint as described under the ulnar sheath infection and the tendon sheath drained from this site. Exceptionally incision upon the radial side alone may be sufficient. If the anterior incision is made, subcutaneous pus may be found, leading to the mistaken notion that the sheath has ruptured and is draining into this area. One should not be deterred from continuing the incision, going a quarter of an inch to the radial side of the median line of the flexor surface of the forearm. The dissection is carried down to the radial side of the flexor sublimis tendons, avoiding the median nerve in the floor and to the ulnar side. The tendon sheath has generally ruptured by this time or can be identified by a grooved director or fine probe passed from the opened sheath below. It is entirely safe to cut the upper part of the anterior annular ligament (Fig. 1266).

If the infection has shown any tendency to be virulent or extend rapidly I feel that this anterior incision should be limited to opening the subcutaneous accumulation, if there be any, and the tendon sheath should be opened by the lateral incisions described above, for entering the space between the flexor profundus tendons and the pronator quadratus. Good-sized incisions should be made so that drainage may be free. In many cases where the infection has been severe or the tendon impaired, primary removal of the tendon should be favored. This is particularly liable to die and remain for many weeks causing the infection to persist and jeopardize other structures, so that I make it a rule if the tendon is at all destroyed or the infection shows a slow recovery to remove the tendon at once. I am also especially inclined to do this if the ulnar bursa has so far escaped involvement, since the preservation of this is particularly to be sought."

The use of drainage-tubes is to be condemned. They are unnecessary if the incisions have been properly made, and are always liable to cause necrosis of tendons. Gauze strips are useless and act as plugs preventing drainage. It is easy to keep the wounds sufficiently open by means of strips of rubber tissue or oiled silk. If these materials are not available, then gauze strips *well smeared* with vaseline or some sterile unguent will serve the same purpose. The dressings must be voluminous and *not* tight. The use of a dorsal splint is valuable. Bier's hyperæmia is an invaluable therapeutic aid and ought never to be forgotten.

CHAPTER CIV

WOUNDS OF JOINTS

1. **Punctures.**

(A) The patient is seen promptly. Clean the skin thoroughly. Apply dressings; cover with a liberal supply of cotton to permit even, elastic pressure. Immobilize by means of splint and starch (crinoline) bandages or of plaster of Paris. Elevate the limb. Carefully watch temperature, pulse, and *pain* for a few days.

(*a*) If all goes well begin motion in about ten days. The elastic pressure usually suffices to assist nature in removing the effusion which always appears. Sometimes if the effusion is great puncture or aspiration is necessary. If the temperature reaches 100° and the pulse 90–100 during the first twenty-four hours after the accident, and especially if pain is *not* severe and throbbing, grave alarm need not be felt.

(*b*) If the temperature and pulse run higher, if pain is a prominent symptom and if there is any hint of a chill, infection is present. There has been no time for any great increase in the number of bacteria present, but along with those introduced, toxins have entered, and the parts have begun to react to the insult. The joint is swollen, red, etc. Vigorous and immediate treatment must be adopted. Arthrotomy with drainage is calculated to give good results. Bier's hyperæmia may be valuable.

(B) (*a*) The patient is seen several days after an injury which has been neglected or inefficiently watched. The signs of arthritis are present—fever, acute and increasing pain, effusion, redness, and perhaps lymphatic involvement. Perform arthrotomy at once. Drain. The drain should be soft and reach to but not into the joint. As soon as possible remove the drain and begin motion. (*b*) Severe advanced infection requires the most free drainage possible and possibly resection. The use of packs moistened with hypertonic salt solutions is very valuable.

2. **Incised Wounds.**—Enlarge if necessary. If required for inspection, cleansing, or drainage, make supplementary incisions. Clean. Provide efficient drainage.

CHAPTER CV

INDICATIONS. JOINTS

It is difficult or impossible to lay down absolute rules regarding operative interference in many cases of articular disease, but a few remarks on the subject may be of value to the junior surgeon.

(A) **Wounds of the Joints.**—(See preceding chapter.)

(B) **Simple hydrops articuli,** generally of traumatic origin. Only if the effusion is great and resistant to treatment by pressure, etc., does it become proper to aspirate and possibly to inject some modifying fluid, such as a 5 per cent. solution of carbolic acid or 2 per cent. formalin-glycerine. If the hydrops is due to the presence of a foreign body (rice body) or its equivalent, *e.g.*, displaced semilunar cartilage, treatment must be directed against the exciting cause.

(C) **Arthritis from Pyogenic Infection.**—(I) The arthritis is not very acute; the general symptoms are not menacing in character; the general condition of the patient is good. Use absolute rest plus some active conservative treatment, *e.g.*, Bier's hyperæmia, or puncture the joint, withdraw the fluid, douche with salt solution, and inject Murphy's formalin-glycerine solution. Watch the case carefully lest more vigorous measures may be necessary.

(2) The arthritis is more acute or is accompanied by menacing symptoms, but yet the patient is not in an alarming condition.

Open the joint sufficiently to provide free drainage, irrigate, introduce drainage-tubes to, but not through the synovialis. According to circumstances, apply suction to the parts by means of the Bier-Klapp cups (this assists drainage and provides hyperæmia) or apply Bier's rubber bandage to produce obstructive hyperæmia and hinder absorption.

(3) The arthritis is very extensive and progressive. Provide the most free drainage possible, lay the joint open as thoroughly as possible and keep it open so that no retention of discharges may be possible (Bier's obstructive hyperæmia may benefit). Do not fear injury to the subsequent function of the joint, the operation is a life-saving one and no thoughts of subsequent disabilities must be permitted to interfere with the providing of thorough drainage. Resection of the joint may be necessary.

(4) The patient's general condition is poor from age, continued disease, etc. He will be unable to withstand a long illness. Amputation is the treatment of choice. In a few cases, *e.g.*, in the hip, resection of the joint may give better prospects of recovery than amputation.

(5) The arthritis is the result of, or is complicated by, osteomyelitis. The treatment must be a combination of that for the bone lesion and of arthrotomy. Atypical or typical excision of the joint will pro[illegible] indicated.

(D) **Tuberculous Arthritis.**—The indications for treatment depend, (*a*) on the general condition and social position of the patient; (*b*) on the local lesions present.

(*a*) **The General Condition and Social Position of the Patient.**—Conservative treatment gives its best results in childhood and youth, during which periods the loss of time involved is of comparatively small importance. The old and feeble require treatment which will give the quickest possible relief with the least tax on their vitality. In youth it is more important to obtain a functionally useful joint than to save time; among the aged and debilitated prompt recovery is more important than functional recovery. The presence of visceral tuberculosis or of amyloid disease spells amputation in most instances, though to this there are exceptions. Amputation often leads to improvement, sometimes to cure, of the internal lesions.

(*b*) **Local Lesions.**

(1) **Non-suppurative Tuberculous Arthritis.**—In every case begin by using conservative treatment, *viz.*, rest with immobilization; Bier's hyperæmia; aspiration with injection of some modifying solution if hydrops is present.

If after a reasonable time (months) there is no improvement, if pain persists, if deformities develop, operation must be considered. When skiagraphy shows the presence of severe osseous lesions, conservative treatment, while it may succeed, yet is not so likely to do so. If the bone lesions do not communicate with the joint, if they can be removed without opening the joint and without injury to an *active* epiphyseal cartilage, then it is wise to excise the diseased foci. In deciding between operative and non-operative treatment, take into consideration the individual joint affected, and the amount of handicap anchylosis of that articulation would impose on the patient.

(2) **Suppurative tuberculous arthritis** without fistula. (No pyogenic infection is present. The disease is a cold abscess of the joint.)

Combined with immobilization, *the* treatment consists in aspiration followed by injections of iodoform. (Iodoform in oil, glycerine, ether, or in formalin and glycerine.) The results obtained are better in children than in adults because in the latter sequestra are usually present. Instead of aspirating one may incise the joint, mop it with gauze, douche with salt solution, rub the joint surfaces with iodoform or with tincture of iodine, close the wound with sutures, fill the joint cavity with iodoform emulsion before tightening the last suture. Bier never uses iodoform injections except in tuberculous hydrops or in cases of large cold abscesses which fill the articular cavities; in these hyperæmia is out of place. Under other circumstances Bier evacuates the pus and treats by means of hyperæmia. Small multiple cold abscesses around a joint are suitable for puncture and suction hyperæmia. If improvement under conservative measures does not manifest itself in a reasonable time, or if the disease shows progress, one must resort to operation—usually typical or atypical resection.

(3) Suppurative Tuberculous Arthritis with Fistulæ.—This means that secondary infection is present as a complication.

(*a*) The disease is not progressing rapidly. On probing no dead or diseased

bone is felt. Clean the fistula with gauze wicks or with a curette. Use suction hyperæmia. Sometimes vigorous suction may take the place of the curette. Treat the main diseases by the usual conservative means. If diseased bone is found at bottom of the fistula, this must be exposed and removed.

(*b*) Instead of treating in the preceding manner, cleanse the fistula, remove any loose sequestra, fill the fistula by injecting into it Beck's bismuth vaseline or his bismuth paste. This frequently leads to recovery.

(*c*) The above measures fail or the disease appears progressive. Symptoms are such that loss of time is dangerous. Perform either typical or atypical resection. Garré makes a valuable protest against carelessness in the treatment of tuberculous arthritis. Unless the fistulæ are kept clean and well protected by dressings, and unless the soiled dressings are sterilized or destroyed, the patient becomes a menace to the community.

(4) The presence of multiple lesions at different parts of the same limb generally demands amputation, though even here general treatment, plus local care, often leads to cure in children.

As 75 per cent. of cases of tuberculous arthritis may be cured by conservative means (Hoffa), do not lightly turn to operation. Remember that the rules guiding the surgeon in his choice of treatment vary according to the social status of the patient, his means to indulge in prolonged treatment, etc., and according to the joint involved.

(E) **Gonorrheal Arthritis.**—Conservative treatment is generally sufficient. Bier's hyperæmia is said to be most valuable. In hydrops articuli and in serofibrinous arthritis, if the above measures do not give relief promptly, it is proper to aspirate and inject some modifying solution, *e.g.*, 5 per cent. carbolic acid solution. In suppurative arthritis incision and drainage are necessary. Whatever means of treatment is adopted, beware of anchylosis and deformities from contracture.

(F) **Typhoidal Arthritis.**—It is extremely rare that typhoidal arthritis leads to suppuration; when it does then incision and drainage are necessary. Hydrops of typhoidal origin, when present, is liable to cause dislocation especially of the hip, hence aspiration is proper.

(G) **Acute Rheumatic Arthritis.**—O'Connor, of Buenos Ayres, is enthusiastic over the benefits to be obtained from incision, irrigation, and drainage of whatever joints are affected. He believes that under this treatment the local lesions recover promptly, pain is relieved at once, and secondary heart troubles are avoided. The author has no experience in the matter, but O'Connor's arguments seem plausible and well backed by results.

(H) **Pneumococcal Arthritis.**—The indications are the same as in ordinary pyogenic infections of the joints.

(I) **Traumatic Dry Arthritis.**—Rovsing finds that injections of sterile vaseline exercise a favorable influence in this painful and disabling disease.

CHAPTER CVI

AMPUTATION OR DISARTICULATION

Esmarch gives the following indications for amputation:

1. Extensive comminution of the bones and laceration of large vessels and nerves.

2. Extensive destruction of the whole musculature of a region even when the bones are not much damaged.

3. Very extensive destruction of skin (ulcer, burns) if the limb is rendered useless by it and repair by skin transplantation is impossible.

4. Gangrene.

5. Malignant tumors.

6. Severe septic or pyæmic infection when removal of the focus is impossible by other means.

7. Suppuration of long duration when the patient's strength is so lowered that it is evident he cannot withstand a long illness and that by amputation he is likely to recover in a short time.

8. Amputation of choice. When the patient desires to be rid of a useless organ, *e.g.*, an atrophied or paralyzed limb.

When amputation is necessitated by gangrene, when ought one to operate? Immediate amputation is called for because the patient is constantly absorbing poisons from the diseased part and is constantly losing strength. Immediate amputation is improper because one does not know where to operate; one does not know where the gangrenous process will stop and hence too much of the limb may be sacrificed or, what is more serious, too little may be removed and gangrene may appear in the stump. It has been exceedingly difficult to decide this question in the past; if intoxication were great it was wise to run chances of recurrence and amputate; if intoxication were not severe and the patient's strength permitted, it was wise to delay until the line of demarcation became evident. Mozkowicz ("La Presse Méd.," Oct. 24, 1906) has endeavored, apparently successfully, to find where the line of demarcation will form in any given case, *i.e.*, to determine the seat of arterial obliteration. His method is the following: Elevate the limb for two or three minutes. Apply an elastic constrictor high up the limb as if for amputation and lower the limb to the table. After five minutes remove the constrictor quickly. In health the arterial circulation re-establishes itself at once, a hyperæmic flush passes down the limb and reaches the toes in about two seconds. If gangrene is present the ruddy flush rapidly passes a certain distance down the limb then pauses so that there is a clear line of demarcation between the skin above (hyperæmic) and that below (ischæmic), then the flushing passes slowly downward, taking

minutes instead of seconds to reach the toes. The line where the descending flush pauses corresponds to the site of arterial obliteration and to the limit which the gangrenous process may be expected to reach. Several surgeons, notably v. Eiselsberg, have corroborated Moskowicz's observations.

Van Buren Knott, when amputating in certain bad cases of gangrene or analogous septic conditions, considers it of prime importance, *first*, to be rapid, and, *second*, to avoid interference with the nutrition of the tissues to be preserved. He fulfills these conditions by making a circular amputation; dividing the skin, the muscles, the bone at the *same level*, attending to hemostasis, applying dressings and then waiting until recovery has so far taken place that it is safe to fashion the stump and divide the bone at a higher level. At the primary operation there is no reflection of the tissues, no separation of one tissue plane from another, no application of sutures and the ligatures are applied to the vessels as precisely as possible so as to avoid strangulation of surrounding structures.

Fitzmaurice-Kelly ("Lancet," Jan. 2, 1915) writes that the "chief conditions calling for amputation in the present war have been compound comminuted fractures and gaseous gangrene. * * * In both a virulent infection is present and ordinary amputations are very frequently followed by recrudescence of the infection in the flaps." He advocates an operation identical with Knott's and claims excellent results provided that the nerves are pulled down and cut short. He amputates very close to the disease, even within half an inch of gangrene, and does not fear spread of the disease. In cases of compound fracture of the femur, with the wounds in the groin and buttock and the fracture just below the trochanter, he amputated below the wounds, enucleating the lower fragment and laying open the sinuses to the surface, with complete success.

When the lesion necessitating amputation is old suppurative disease, sinuses in the tissues forming the flaps do not appear to do much harm if they are well cleaned by dissection, curettement, and chemical disinfection (H. Barnard). Recognition of this fact tends to conservatism.

Patients who have lost much blood bear major amputations of the lower limbs badly; when gangrenous septicæmia is a complication the outlook is very bad. Savariaud had obtained excellent results in apparently desperate cases as follows: Anesthesia by ether. Preventive hemostasis by elastic constrictor (if necessary Momberg's). After the limb has been amputated and all bleeding points clamped or tied, introduce a cannula (the cannula is conical, with an aperture of 2 mm. at its point while its base is about the size of a little finger) into the femoral vein and at once inject about 1500 c.c. of warm saline solution. The injection takes only about 2 or 3 minutes. The rapid infusion so raises the blood pressure that the small arterioles of the stump begin to bleed and can be ligated, thus lessening the danger of poster operative hemorrhage.

When and Where to Amputate a Limb after Injury.—W. L. Estes has thoroughly studied this question, his experience is vast and his ideas are well worth consideration. The following paragraphs are based on Estes's publication ("International Journ. of Surg.," June, 1905):

1. The aged and very young are intolerant of long confinement, hence are less suitable to conservative treatment than other individuals. Chronic alcoholics, diabetics, nephritics, etc., are unsuited to long-lasting conservative treatment. Tuberculosis of moderate degree does not seriously interfere with conservatism. The best subjects for conservatism are robust individuals of good habits in early adult life and children above ten years of age.

2. Severe laceration and crushes from falls or blows over restricted areas are more suitable for conservatism than when they are due to squeezes or pressures of heavy machinery, heavy stones, or car wheels. These latter injuries correspond more or less to such as are produced by the angiotribe.

3. Thick muscular portions of a limb stand more injury than thinner parts. Crushes of bone and muscle even where extensive admit of conservative efforts if the "*skin is not fatally injured over a considerable area*, say half of the periphery of the limb at the seat of injury." If the principal vessels of the thigh or upper arm are severed and laceration is extensive, amputate. If in forearm only one system of vessels and nerves is severed, *e.g.*, the radial, and the skin is not badly damaged, try conservatism. If both radial and ulnar systems are badly damaged, amputate. The same principles apply to the leg.

4. Psychical shock due to profound nervous disturbance from fear or horror is often improved under ether, and hence immediate amputation may be performed. Anæmic shock demands treatment by means of salt solution (intravenous, hypodermic, rectal), bandaging of the extremities, warm bed, morphia, etc., and amputation must be delayed until reaction sets in, twelve, twenty-four, or thirty-six hours. Crile's direct transfusion is useful.

5. If the physical condition is not very bad, and if there is no doubt as to the necessity of amputation, do not delay.

6. When shock from the operation is much feared, then Crile's method of nerve-blocking (p. 1186) may be valuable.

7. When delay is necessary, hemorrhage must be absolutely controlled and cleanliness sought.

(*a*) Amputation is inevitable. Apply an elastic constrictor (Estes) over already injured tissues just far enough above the severed muscles and bones to assure it against slipping. The tissues compressed by the tourniquet are already so injured that they must be sacrificed and hence the extra constriction is harmless. The constrictor does not merely prevent hemorrhage; it also prevents absorption, a matter of prime importance as disinfection of the lacerated wound is usually impracticable. The constrictor should be left in place *until after* the amputation, a second tourniquet being applied at a higher level during the operation. The lacerated wound must be covered by a large moist antiseptic dressing. If in spite of these precautions infection reaches above the tourniquet, immediate operation is imperative.

(*b*) There is reasonable doubt as to the absolute necessity of amputation. Do *not* apply the elastic constrictor temporarily. Clean and disinfect the wound. Ligate vessels. Remove the constrictor. Pack the wound with gauze, if desirable, placing a sheet of perforated oil silk between the gauze and

the tissue to prevent adhesion. Possibly introduce one or two sutures to keep the packing in position. Apply voluminous dressings and a splint. Bandage snugly. The size of the dressings gives elasticity to the pressure of the bandage. Elevate the limb. After twenty-four to fifty-six hours proper conservative operations or amputation may be performed.

8. If the injury affects the fingers or hand the character of the amputation will depend to some extent on the occupation or social position of the patient, *e.g.*, an irregular, "nobby" stump may be of vast service to a workman (Fig. 1357); a neat, smooth one may be far more pleasing to a fashionable lady. As a rule, in the case of the fingers, hand, and arm, as much of the limb must be saved as possible, in the case of the lower extremity several problems arise.

(*a*) The patient can afford a good artificial limb. In this case the ideas of the artificial limb-makers must be consulted. According to them the lowest favorable point for section of the bones in amputation of the leg is about 8 inches from the ground; the highest point is about four inches below the lowest edge of the patella; the lowest point for section of the femur in amputation of the thigh is about 3 to 4 inches above the knee-joint, the highest about 5 inches below the crotch.

FIG. 1357.—(*Jacobson.*)

(*b*) The patient cannot afford a good artificial limb. As much of the limb must be saved as is possible, and if possible a natural weight-bearing surface be provided for the stump as in Chopart's and Syme's amputations.

(*c*) Remember that if amputation be done through the upper third of the humerus in children, the bone left will grow and form a conical stump which may require reamputation. A warning of this fact given to the patient's guardians may save the surgeon's reputation. Conical stump is also liable to develop after amputation through the upper part of the femur in children.

9. The dangers to life are almost alike in amputations at any level of the arm and forearm. Practically all amputations below the knee are equal in safety; above the knee the higher the amputation the greater is the danger.

The Character of the Stump.—The character of the stump is of importance. As already stated, when the patient cannot obtain a good artificial limb the stump ought, if possible, to be covered with skin and tissue already accustomed to bearing weight, and the scar ought *not* to pass over the end of the bone. If an artificial limb is to be worn a number of experienced artificial limb-makers consider the best site for the scar to be directly over the end of the stump and not at the side. The prime desideratum is to have the end of the bone well cushioned with soft tissues and to have sufficient length of stump for the application of the artificial member. The osteoplastic methods of amputating are

well calculated to produce good useful stumps, but are more suitable in cases when disease rather than trauma necessitates the operation.

Circular Amputation.—Circular amputation is the basis of all methods of amputating.

Example: Amputation of the arm. Place the patient on his back with the arm held well out from the table. Apply an elastic constrictor around the limb near the shoulder.

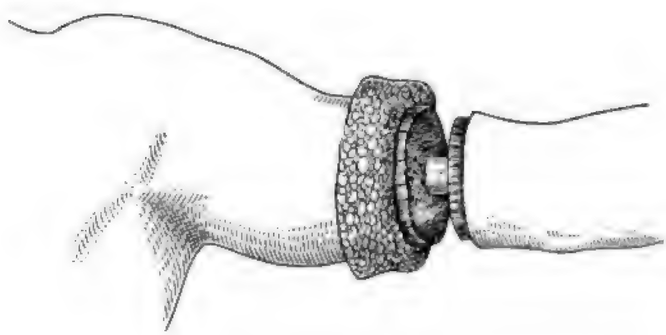


FIG. 1358.—Circular amputation.

Step 1.—Let the first assistant pull the skin of the arm upwards as far as possible. Note the diameter of the limb at the point chosen for section of the bone. At a distance below this point equal to three-fourths the diameter of the limb make an incision completely around the limb through the skin and down to the deep fascia. Reflect the skin and superficial fascia upwards for a distance of 1 to 1½ inches (Fig. 1358). At this level make a circular incision through all the remaining soft parts to the bone. J. N. Jackson insists that it is better to incise the deep fascia in the first cut and to reflect it along with the

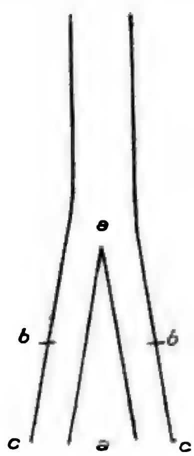


FIG. 1359.

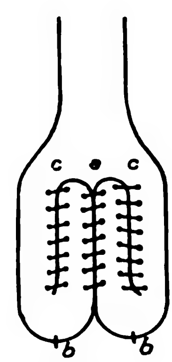


FIG. 1360.

FIGS. 1359 AND 1360.—Treatment of divided nerves. (*Bardenheuer.*)

superficial structures from the muscles. The author agrees with him in this as the resultant stump is excellent.

Step 2.—(*a*) Make a circular incision through the periosteum at the level of the muscular wound. Reflect the periosteum from the bone for about ½ to ¾ inch upwards and divide the bone at this level. A long oval anterior periosteal flap is as efficient and is more easily made. The reflected periosteum forms flaps to cover the sawed surface of the bone.

(*b*) Separate the muscles from the bone and periosteum up to a point about ½ to ¾ inch above that chosen for section of the bone. At this level divide the periosteum and reflect it *downwards*. Divide the bone at the chosen level. The result of this is that the distal end of the bone in the stump is bare. Hirsch and Bunge find that the absence of the periosteum tends to the production of a nontender stump. Bunge for the same purpose scrapes out the marrow near the divided end of the bone.

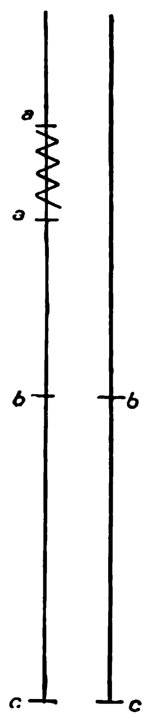


FIG. 1361.

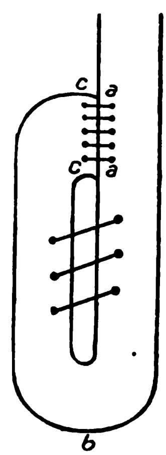


FIG. 1362.

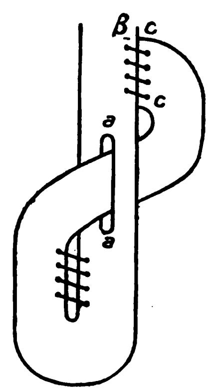


FIG. 1363.

FIGS. 1361, 1362 AND 1363.—Treatment of divided nerves. (*Bardenheuer.*)

Experience in the Russo-Japanese war showed the benefit of the Hirsch-Bunge methods.

Step 3.—Look for vessels in their normal locations and tie them. The main vessels run in the intermuscular septa, but many muscular vessels also require attention. Nerve trunks ought to be pulled out of their sheaths as far as possible and divided; this precaution often saves much after-pain. To prevent the formation of stump neuromata and to obviate the recurrence of these painful neoplasms, when they have been excised, Bardenheuer ("Deutsche Zeitschrift für Chir.," xcvi) treats their divided ends in such manner as to avoid leaving raw surfaces in the wound. Figures 1359, 1360, 1361, 1362 and 1363 are self-explanatory. Senn, in 1896, made a similar recommenda-

tion, viz., to remove a V-shaped section of the end of the nerve and bring the surfaces together by fine sutures.

Apply hot pads to the wound. Remove the elastic constrictor. Bit by bit remove the hot pad from the wound; pick up with forceps any bleeding vessels; ligate the vessels. Apply to the wound pads wrung out of hot water until the oozing stops.

Step 4.—Obliterate all dead spaces by means of buried catgut sutures or by relaxation sutures. Close the skin wound by sutures converting the circular into a transverse wound. If it is impossible to obliterate the dead spaces, if oozing is expected or if asepsis is not sure, provide drainage either by tube, rubber tissue, or cigarette. Apply dressing and a splint.

Credé ("Archiv für klin. Chir.," xlviii, 514) advocates the abolition of sutures after amputation. In place of them he uses a sort of capeline bandage of wide-meshed gauze, applied directly to the stump. After one or two layers of the bandage have been applied it is easy to see, through them, if the edges

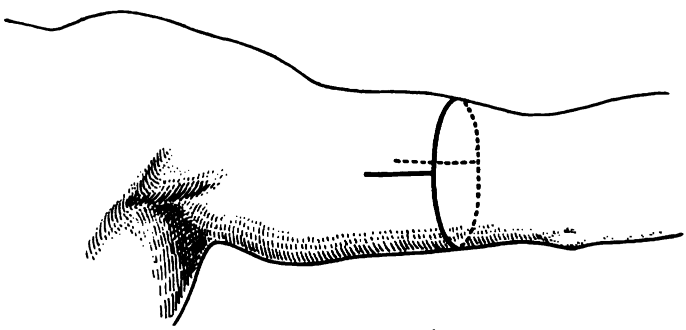


FIG. 1364.

of the wound are in correct apposition and if the compression exercised by the bandage is too severe. Outside the bandage he applies the usual dressings.

When, owing to the conical shape of a limb, it is impossible to reflect the tissues upwards to a sufficient extent through the circular incision, it is easy to make one or two lateral incisions through the soft parts and so facilitate the work (Fig. 1364). Thus we have the racquet incision and amputation by two equal flaps. If, instead of making the original circular incision exactly transverse, it is made oblique, the result is an oval incision or practically an amputation by a single flap and the resultant scar is not over the middle of the stump. By means of lateral longitudinal incisions (Fig. 1364) the oval amputation may be converted into one having unequal flaps.

When the surgeon desires to amputate by the flap method he of course would never dream of making the flaps in the indirect method described above, but would trace them out directly and fashion them either by cutting first through the skin and then through the musculature or by transfixion.

Amputation by transfixion is performed as follows.

Example, amputation of the lower third of the thigh:

Bring the patient so as to rest with his buttocks on the lower edge of the

table. Have an assistant hold the limb well free from the table. Apply the elastic constrictor after elevating the limb to render it anæmic.

Step 1.—Retract the skin upwards. At the middle of one side of the thigh opposite the point where the bone is to be divided, pass a long amputating

FIG. 1365.—Amputation by transfixion. (*Burghard.*)

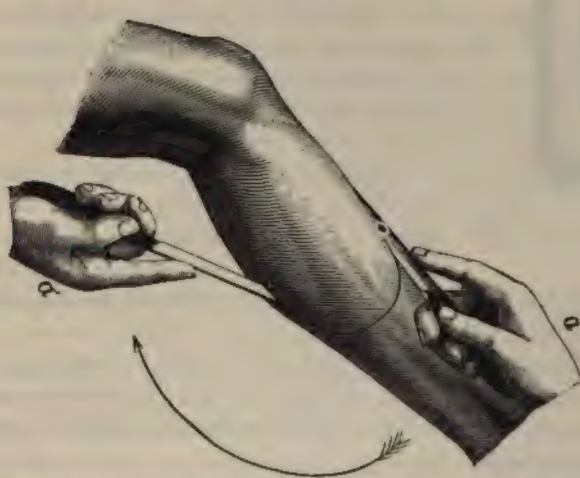


FIG. 1366.—Amputation by lateral skin flaps. (*Farabeuf.*)

knife through the limb immediately in front of the femur and make its point emerge through the skin at a place directly opposite the point of insertion

(Fig. 1365). Cut downwards and forwards so as to make a flap of sufficient length and thickness.

Step 2.—Through the original wound once more pass the knife, but make it go behind the bone. Cut downwards and backwards so as to make a posterior flap of sufficient length and thickness.

Step 3.—Retract the soft parts for a short distance up the femur. Make a circular incision so as to bare the bone at the site where it is to be divided. Divide the bone with a saw.

Step 4.—Attend to hemostasis. Close the wound as already described.

FIG. 1367.—Circular division of the muscles. (*Farabeuf.*)

How long ought the flaps to be? They ought to be long enough to cover the end of the bone without tension, for this purpose the length of the *combined* flaps should be equal to $1\frac{1}{2}$ times the diameter of the limb at the point of bone section.

A combination of methods is sometimes useful, *e.g.*, the skin and superficial fascia may be fashioned into flaps and the deep structures divided in the circular fashion.

Example.—Amputation of the leg: Support the leg free from the table. Apply the elastic constrictor.

Step 1.—With a scalpel trace out a flap on the inner side of the leg. The incision outlining the flap begins in the middle line in front and ends at a corresponding point behind after running a horseshoe-shaped course (Fig. 1366). Beginning and ending at the same points trace out an identical flap on the outer side of the leg. Reflect these flaps, consisting of skin and superficial fascia, upwards until their bases are reached. If the fascia lata is included in the skin flap the resulting stump is liable to be more satisfactory.

Step 2.—Make a. circular incision through the muscles to the bone (Fig. 1367). It is well to make the cut through the muscles posterior to the bone at a lower level than that through the anterior muscles so as to allow for their greatest retraction. Divide the interosseous ligament and the periosteum.

Step 3.—Divide the bones with a saw. Remove rather more of the fibula than of the tibia. With a saw or bone-cutting forceps remove the sharp angle formed by the crest of the tibia. (Treat the periosteum in the manner described in circular amputation.)

Step 4.—Attend to hemostasis. Close the wound, etc.

In cases of injury the surgeon may be compelled to combine various methods to suit the case. For example: The tibia and fibula are badly comminuted up to a point [illegible] inches below the knee; the skin, muscles, vessels, etc., are

badly lacerated and contused to the same level on the outer side of the leg, the soft parts on the inner side of the leg are more or less intact. The injury is sufficient to demand amputation. There is ample tissue to cover the stump if amputation is performed below the knee, but none of the typical operations are calculated to utilize the material present. In our example the surgeon makes a long flap from the structures on the inner and posterior sides of the leg and gets a good result. Much may be done by ingenuity in obtaining viable flaps, to save a very useful portion of a limb which would otherwise be sacrificed.

In the pre-anesthetic days when haste was absolutely necessary flap amputations were especially favored as they could be speedily accomplished by transfixing the limb with a very long knife and cutting from within outwards. To-day any limb may be amputated by means of a scalpel (preferably with a blade 2 to 3 inches long) and any cross-cut saw, plus, of course, the usual equipment of scissors, forceps, etc. Liston's bone forceps or a rongeur forceps are useful for trimming the roughnesses from the bone stump.

A lion-jawed forceps is useful for steadying the end of the bone while an additional slice is being sawed off, if the line of section was made too low.

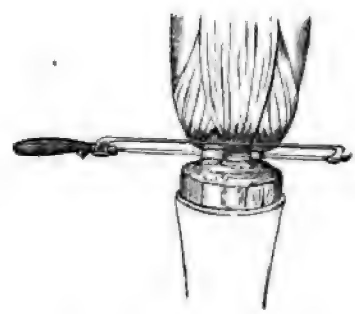


FIG. 1368.—Retraction of muscles with three-tailed bandage during bone-section. (*Esmarch and Kowalzig.*)

Some surgeons, instead of dividing the bone *after* section of the soft parts has been completed, expose the bone at the chosen place by a longitudinal incision, separate it from its surroundings, divide it with the chisel or Gigli wire saw, and then complete the section of the soft parts.

When amputation is being performed through the leg or forearm it is not always easy to retract the soft parts out of danger from injury by the saw. Special metal retractors have been devised for this purpose, but a three-tailed bandage suffices (Fig. 1368).

It would be useless and wearisome to describe all the methods of ordinary amputation.

SPECIAL AMPUTATIONS

Upper Extremity.—Amputation of the Fingers.—Except when a symmetrical hand is more desirable to the patient than a useful one, the absolute rule must be to preserve as much stump as possible as long as that stump is provided with tendons.

Disarticulation of Distal Phalanx.—Flex the phalanx strongly. Make a transverse incision on the back of the finger into the joint (Fig. 1369). This severs the insertion of the extensors. Divide the lateral ligaments. From each end of the transverse incision make lateral incisions down to the bone of the phalanx to be removed. Separate the phalanx from the soft parts on its palmar side (Fig. 1370) until sufficient of the soft parts has been separated

to cover stump. Divide the palmar flap transversely and if necessary trim it. Attend to hemostasis. Close the wound with sutures. The resulting scar is dorsal.

Disarticulation of Middle Phalanx.—Identical with the preceding.

Amputation through the proximal phalanx is a good operation, provided that the divided tendons are sutured to the contiguous theca (J. D. Byrant).

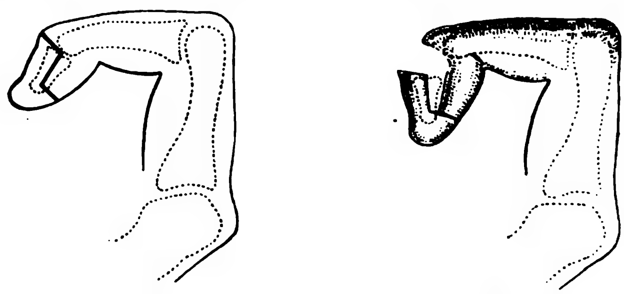


FIG. 1369. FIG. 1370.

FIGS. 1369 AND 1370.—Amputation of finger.

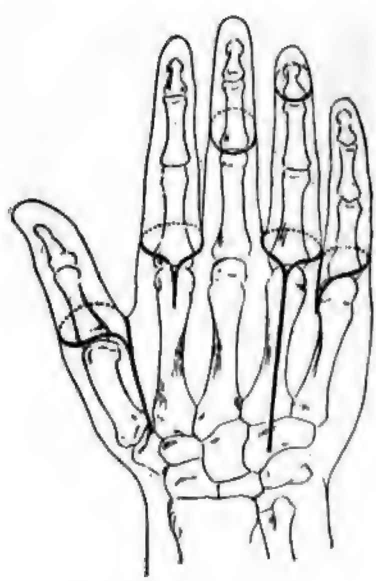


FIG. 1371.—(*Kocher.*)

FIG. 1372.—(*Veau.*)

For division of the bone of the phalanx Gigli's wire saw is preferable to bone-cutting forceps as the latter causes splintering.

In amputating for injury remember that any method is good which provides a well-covered useful stump.

Disarticulation at the Phalango-metacarpal or at the Metacarpo-carpal Joints.—Figures 1371, 1372, 1373, 1374, 1375, 1376, 1377, 1378, sufficiently

explain these operations. Note that none of the longitudinal incisions are made in the palm.

After metacarpo-phalangeal disarticulation the resultant stump is liable

FIG. 1373.—(*Veau.*)

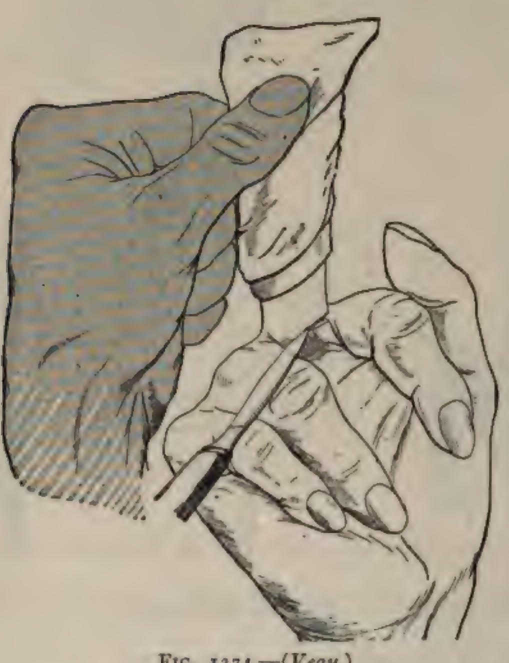


FIG. 1374.—(*Veau.*)

to be so prominent as to interfere with the patient carrying out handiwork, a serious matter to certain classes of mechanics. Figure 1374 shows how section of the distal end of the metacarpus overcomes this very real disability.

"When removing the metacarpus of the thumb or of the little finger it is

of much importance to preserve intact the short muscles of the thenar a hypothenar eminences, because by so doing a very useful and movable stu is obtained, especially if the bone is removed subperiosteally.

In disarticulating a finger, with or without its metacarpal bone, the tra verse incision follows exactly the line of the web of the fingers; incisions mu not be made higher up in the palm" (Kocher).

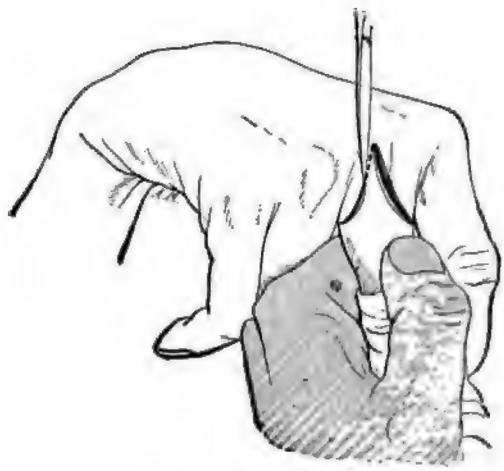


FIG. 1375.—(*Veau.*)

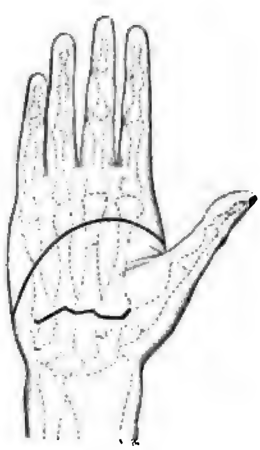


FIG. 1376.
(*Esmarch and Kowalzig.*)

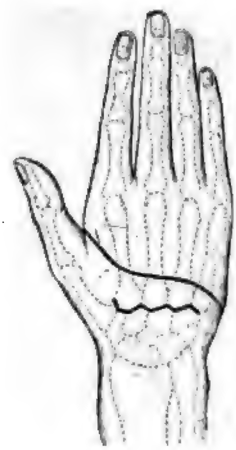


FIG. 1377.
(*Esmarch and Kowalzig.*)

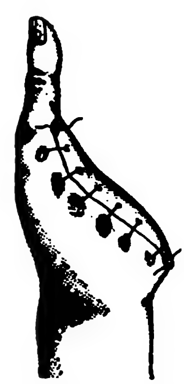


FIG. 1378.
(*Esmarch and Kowalzi*

Amputation at, or Disarticulation of the Wrist.—Do *not* make a ty amputation here if it is at all possible to save a portion of the hand or a mov finger.

Kocher recommends an obliquely circular (oval) incision so as to fo palmar flap (Figs. 1379–1380). Figures 1381–1382 show a method na after various surgeons (Poupart, Dubrueil, v. **Walther).**

Amputation through the Forearm Requires no Special Notice.

Disarticulation of the Elbow.

(A) **Circular Incision.**—(1) Make a circular cut through the skin and superficial fascia about 2 inches below the condyles of the humerus. Reflect the skin upwards so as to expose the joint.

(2) Strongly extend the joint. Open the joint by a transverse incision in front. Divide the lateral ligaments.

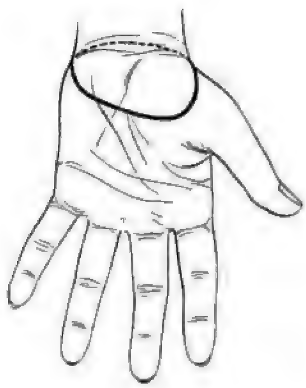


FIG. 1379.

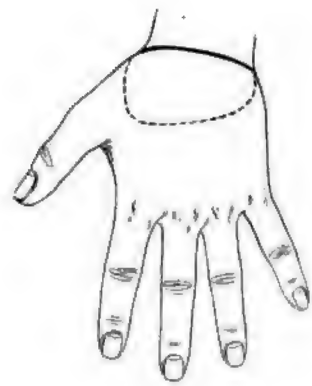


FIG. 1380.

FIGS. 1379 AND 1380.—Kocher's method.

FIG. 1381.—(*Esmarch and Kowalzig.*)

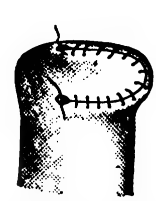


FIG. 1382.—(*Esmarch and Kowalzig.*)

(3) Hyper-extend the joint until the olecranon projects into the wound. Divide the tendon of the triceps at the tip of the olecranon. Attend to hemostasis. Close the wound.

(B) **Kocher's Method.**—(1) Flex the elbow to an angle of 135°.

(2) Make an obliquely circular (oval) incision round the limb (Fig. 1383). Anteriorly the incision is at the joint level (*i.e.*, just above the level of the head of the radius), posteriorly it is a hand's breadth below the tip of the olecranon.

Estes justly criticises this incision by saying, "the soft tissues of the anterior surface contract very markedly, those of the posterior not at all or very little, so that a circular incision at the elbow will become by the contraction of the tissues an oval one with a long posterior flap; it is necessary to bear this fact in mind so that the posterior flap may be made sufficiently long."

(3) Reflect the posterior flap, consisting of skin, fascia muscle and periosteum upwards to the posterior surface of the humerus.

(4) Divide the ligaments. Remove the limb.

(5) Close the wound after attending to hemostasis.

(C) **Farabeuf's operation** is similar to Kocher's but **he obtains his main** flap from the front instead of from behind.

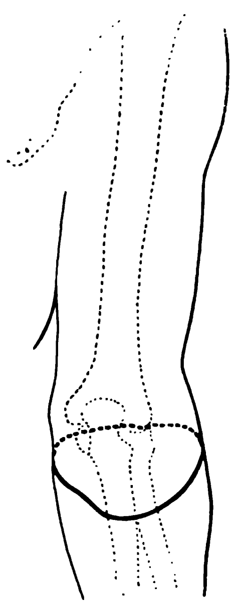


FIG. 1383.—Kocher's amputation at elbow.

Amputation of the Arm Requires no Special Comment.

Amputation at the Shoulder-joint (Disarticulation).—Methods of attaining hemostasis **before dividing the** vessels:

(*a*) Pressure by finger or padded **key, on the** subclavian artery. This is unsatisfactory **as movements** of the shoulder, necessary during the **amputation, are** likely to interfere with its success.

(*b*) An elastic constrictor applied above Wyeth's pins, introduced as in Fig. 1384. This method acts admirably. If the vessels are caught in forceps *before* the joint is disarticulated it is always efficacious.

(*c*) Preliminary ligation of the subclavian artery is valuable in case of large, vascular tumor about the head of the humerus.

If the surgeon and his assistant use their brains as well as their hands, it is easy to control hemorrhage in the course of the operation. A glance at Fig. 1385 shows the principal arteries which will be encountered.

(*d*) Pass an elastic constrictor round the shoulder behind or proximal to the coracoid and acromion processes. To prevent slipping, pass a loop of ordinary bandage under the constrictor and have an assistant pull this towards the opposite shoulder. This is a very efficient method.

Jacobson mentions that there are about thirty-two methods for disarticulating at the shoulder. Only a few types will be described here. **Remember** that when there is much laceration of the shoulder the stump may **be covered** by any available viable skin and give a good result.

Remember also that it is imperative when amputating for **malignant disease**, to sacrifice too much rather than **too little, and that if all the tissues which** are usually employed to cover the **stump have been removed, it is easy to obtain** the necessary tissue **in the shape of flaps taken from the chest.**

Method A.—Hold the **arm at right angles to the chest.**

FIG. 1384.—(*Wyeth.*)
Shoulder-joint amputation. Pins and rubber-tube tourniquet in position.

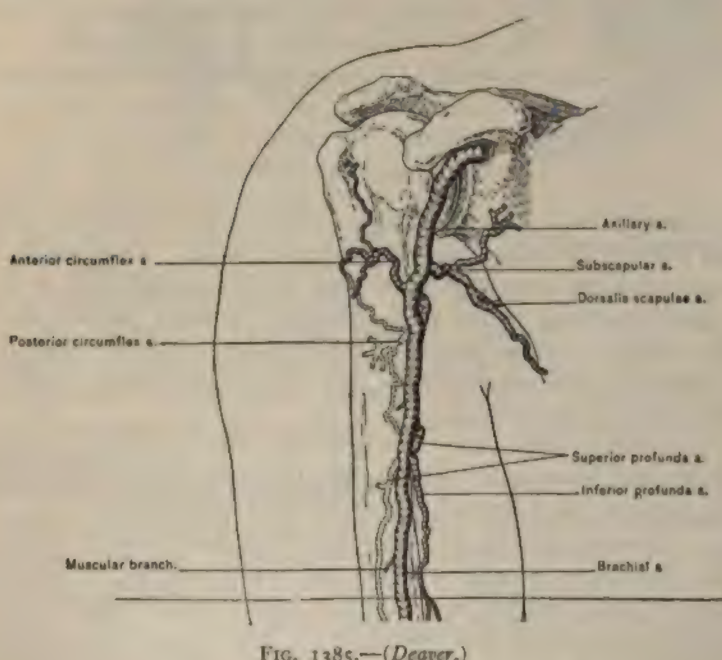


FIG. 1385.—(*Deaver.*)

Step 1.—From the apex of the axilla make a 4-inch longitudinal incision down the arm immediately behind the anterior wall of the axilla along the inner and posterior border of the coraco-brachialis (Fig. 1386). Elevate the pectoralis major and under it divide the deep fascia so as to expose the coraco-brachialis. Pass the finger between the coraco-brachialis and the packet of axillary vessels and nerves.

Separate the vessels (artery and vein) from the nerves and divide them (the vessels) between ligatures. Pull the nerve trunks downwards and divide them high up.

Step 2.—At right angles to the original incision make a circular cut down to the bone all round the arm at the level of the insertion of the deltoid. Separate the soft parts from the bone up to its head. Disarticulate.

Step 3.—Review the wound. Trim away redundant tissue. Suture. Dress.

Method B.—Spence's operation or racket method.

Step 1.—Slightly abduct arm. Rotate humerus outwards. Beginning immediately external to the coracoid process make an incision downwards

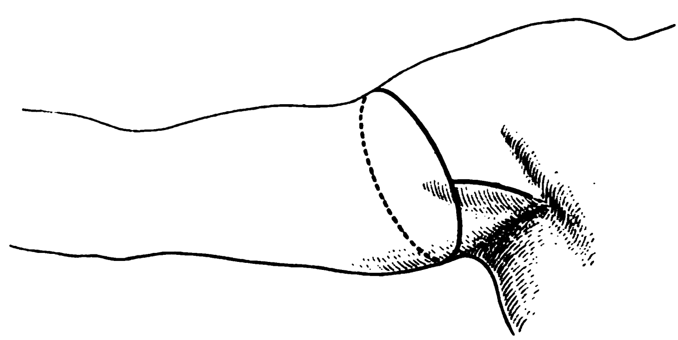


FIG. 1386.—Amputation at shoulder.

to the insertion of the pectoralis major, which is cut. This cut divides the clavicular fibres of the deltoid and the pectoralis major. Continue the incision in a curve round the outer side of the arm to the posterior fold of the axilla. The incision penetrates to the bone, dividing the lower part of the deltoid.

Step 2.—Make a similar incision round the inner or axillary side of the arm, *but only divide the skin and superficial fat.* This inner incision does not reach such a low level as the outer one.

Step 3.—Separate the outer flap from the bone and joint. Retract the flap upwards and backwards together with the trunk of the posterior circumflex, thus exposing the head and tuberosities of the humerus.

Step 4.—Cutting directly on the tuberosities and head of the humerus, divide the tendinous insertions of the capsular muscles. By thorough retraction of the outer flap and by hugging the bone with the knife injury to the posterior circumflex artery is avoided; this is important as, if punctured, this artery is not easy to pick up with forceps and its obliteration endangers the nutrition of the deltoid and skin (Treves).

Step 5.—Let the assistant who is holding the arm so manipulate it that the head of the humerus is thrust upward and outward to project well above the glenoid cavity. Grasp the head of the bone and pull it outwards. Hugging the inner side of the bone, cut the posterior part of the capsule. The arm is now connected with the body by the axillary tissues alone. Let the assistant grasp these tissues with his hand so as to control the vessels they contain. Instead of the fingers a gastroenterostomy clamp may be used for this purpose. Divide the axillary vessels along the line marked in Step 2.

Step 6.—Ligate the vessels. Cut the axillary nerves short. Close the wound. J. Hutchinson, Jr., advises that all the synovial membrane be excised as a discharge of synovial fluid sometimes delays union.

Method C.—Amputation by Superior and Inferior Flaps.—Bring the patient to the edge of the table. Raise the arm enough to relax the deltoid.

Step 1.—Lift the deltoid with the left hand. Pass a long, narrow, strong knife from a point just below the coracoid process under the deltoid and close to the anatomical neck of the humerus, to emerge at a point a little *below* the most prominent part of the acromion. (The transfixion may be accomplished in the reverse direction equally well.) After transfixing, cut downwards and outwards so as to make a rounded flap well down to the insertion of the deltoid.

Step 2.—Reflect the flap. Expose the joint. Divide the capsule by cutting on the head of the bone. Vigorously rotate the arm outwards and divide the subscapularis and biceps. Rotate the arm inwards and carry it across the chest so as to expose and divide the muscles attached to the great tuberosity.

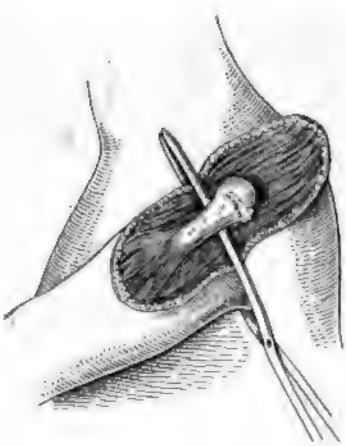


FIG. 1387.—Control of vessels in shoulder amputation.

Step 3.—Dislocate the head of the bone. Divide the capsule behind the head of the humerus. Grasp the undivided structures firmly in a gastroenterostomy clamp; this controls the axillary vessels (Fig. 1387). Slip the knife behind the head of the bone. If the clamp has not been applied as above, have the assistant grasp the soft parts to be divided *behind* the knife. Cut along the shalft of the humerus and make an inferior flap half the length of the superior. The rest of the operation is the same as in Method B.

Method D.—Furneax Jordan's Method.—Apply an elastic constrictor high up. Divide the soft parts down to the bone, as in circular amputation, 3 to 4 inches below the axilla. Secure the vessels. Make a longitudinal incision along the outer and posterior aspect of the limb at right angles to the circular cut. Remove the bone. This method is capable of many modifications and may be carried out after arthrotomy has shown that the limb cannot be saved. The same may be said of Spence's operation.

In operations for malignant disease in the aged or in the presence of profound depression or shock, Crile blocks the nerve trunks and operates under what Harvey Cushing calls regional anesthesia.

Crile's Method in Shoulder Disarticulation (Problems Relating to Surgical Operations, Crile, 1901):

Step 1.—Under infiltration with 1/10 per cent. cocaine solution. Make an incision along the outer margin of the sternomastoid just above the clavicle. Divide the deep fascia.

Step 2.—Retract the omo-hyoid downwards, the anterior margin of the trapezius backwards, the posterior margin of the scalenus anticus forwards

FIG. 1388.—Crile's disarticulation of shoulder. (*Crile.*)

(Fig. 1388). This exposes the trunks of the brachial plexus and by extending the dissection a trifle downwards the arching subclavian artery is seen. When dissecting look out for small nerve twigs in the connective tissue planes or accompanying blood-vessels. Anesthetize such nerves before dividing them.

Step 3.—Inject each nerve trunk with just sufficient cocaine solution (1/2 per cent.) to cause a localized swelling. The injection is made first into the outer covering, then into the substance of the trunk.

This "blocking" causes complete loss of sensation and motion in the parts supplied by the brachial plexus.

Step 4.—Apply Crile's clamp with blades protected by rubber tubing, to the subclavian artery.

Step 5.—Amputate by one or other of the methods described.

cuts on the outer and posterior aspects over the deltoid should be made low down to avoid skin supplied by the cervical plexus.

Intrascapulo-thoracic Amputation.—J. William White finds that the mortality after this operation is not more than 10 per cent., probably 6 per cent., and that about 20 per cent. of the patients who survive operation remain well after three years. The indications for interscapulo-thoracic amputation are (*a*) extensive injury; (*b*) malignant disease of the humerus or shoulder-joint; (*c*) Lund has done this operation for sarcoma of the brachial plexus otherwise irremovable.

FIG. 1389.—Interscapulo-thoracic amputation.

Photograph taken a few days after operation. Note the numerous scratches and shallow incisions made to prevent stagnation of fluids in the flaps which were under considerable tension. As shock was severe the wound was hastily closed hence the imperfect skin coaptation. Union was perfect in about three weeks. When seen three years later the patient seemed well.

Berger ("Revue de Chir.," Oct., 1898) considers that disarticulation at the shoulder does not give sufficient guarantee against recurrence of malignant neoplasms of the upper end of the humerus. When recurrence takes place after disarticulation, the disease propagates itself along the scapulo-humeral muscles. Interscapulo-thoracic amputation removes *en masse*, these routes of dissemination; it further so opens the axilla as to discover enlarged glands which would otherwise escape detection.

The only reservation Berger makes to the above doctrine is the following: Some relatively benign tumors of bone do exist (giant-cell sarcomata; chondromata; myxomata perhaps) and recovery may follow a limited resection, *i.e.*, excision of the tumor itself. To justify a conservative operation, the tumor must be clearly circumscribed and encapsulated; there must be no prolongation

either along the muscles or into the shoulder-joint; microscopical examination of a segment of the tumor, made at the time of operation, must verify the diagnosis of the exact nature of the neoplasm.

Le Conte's Method.—Le Conte ("Congrès International de Médicine," 1900) gives an admirable account of the operation as performed by himself. It is as follows:

1. The incision begins over the sternal end of the clavicle, is carried along that bone to about its middle, and then curved downward to the anterior axillary fold. The skin and superficial fascia are dissected up, exposing well the inner two-thirds of the clavicle.

2. The clavicle is disarticulated by severing its attachments to the sternum and the rhomboid ligament; the clavicular attachment of the sterno-cleido-mastoid muscle is cut close to the bone, and the clavicular portion of the pectoralis major is separated with the finger from the costal portion of the muscle up to the anterior axillary fold.

3. The clavicle is now pulled upwards and forwards, and the attachment of the subclavius muscle is divided at the first rib. The pectoralis minor will now be well exposed, and it is divided and the coracoid portion reflected upwards with the clavicle. This exposes the axilla fully, and the vessels are seen traversing it from the anterior scalenus muscle down.

4. The sheath of the vessels is opened and the vein separated from the underlying artery. Two ligatures are passed, about 1 inch apart, around the artery and tied. The arm is then held up to empty it of blood, while two ligatures are passed around the vein, but these are not tied until the arm is blanched. This renders the use of an Esmarch bandage unnecessary. It must be noted that the cephalic vein has joined the axillary below these ligatures, or else a separate ligature of that vessel is required.

5. The vessels are now severed, together with the brachial plexus of nerves and the costal portion of the pectoralis major. This completes the division of the anterior attachments of the arm.

6. A posterior incision is now carried from some point on the anterior incision (as near the tumor as it is deemed advisable to go) directly backwards and downwards to the inferior angle of the scapula and up again to the posterior axillary fold. The skin and superficial fascia are dissected up for a short distance.

7. The trapezius is severed and the transversalis colli or posterior scapular artery secured; the omo-hyoid muscle is cut and the supra-scapular artery secured, and the muscles attached to the inner border of the scapula are rapidly divided close to the bone. Then, the serratus magnus and latissimus dorsi are cut, the latter at the posterior axillary fold. The arm is now held to the body by the skin of the axilla alone. If there is sufficient flap to cover the wound, the anterior and posterior incisions are joined through the axilla, but if more skin is needed, a flap may be raised from the under surface of the arm. The wound is then closed with suitable provision for drainage.

Figure 1389 shows the appearance of the wound in a patient operated on by the author.

Figures 1390 and 1391 show how Lynn Thomas uses his forceps-tourniquet in interscapulo-thoracic amputation.

Crile's Method.—Under general anesthesia make an incision over the clavicle and resect the inner half of the bone so as to expose the subclavian vein and the trunks of the brachial plexus. Inject each nerve trunk with a ½ per cent. solution of cocaine or eucaine; this "blocks" them. Divide the brachial plexus. Ligate the subclavian artery and vein. During the rest of the opera-

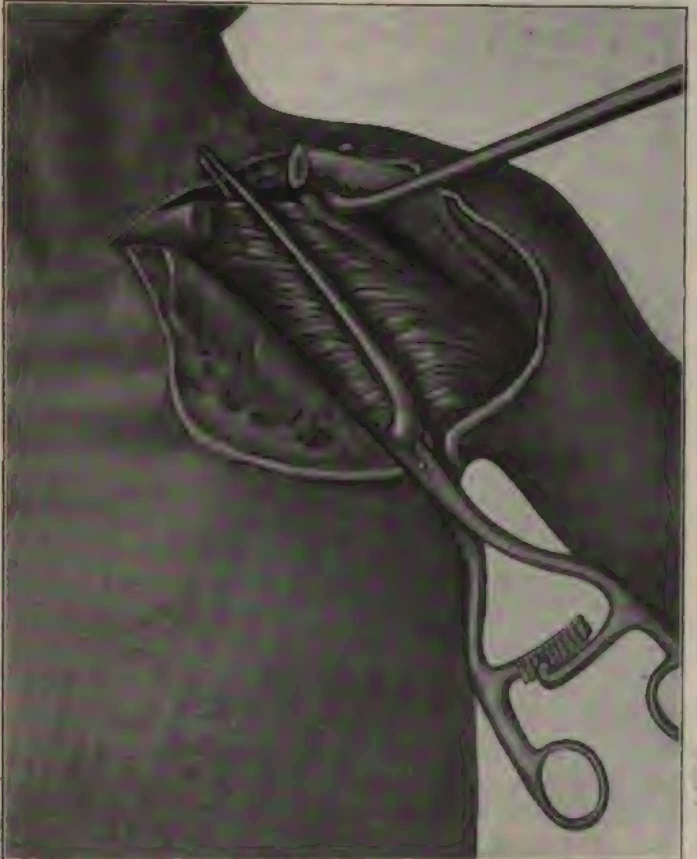


FIG. 1390.—Lynn Thomas' forceps-tourniquet. (*Thomas.*)

tion (already sufficiently described) "the amount of shock will be limited to what would be produced by making the incision through the structures supplied by the nerves from the cervical plexus, which is almost *nil*."

Le Conte recommends the disarticulation of the sternal end of the clavicle in preference to a resection of the middle portion of that bone, for the following reasons:

1. It gives the widest and fullest possible exposure of the vessels and decreases the accidents of ligation to a minimum.

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2. It insures the securing of the artery first, before the vein is tied, enabling one to elevate the arm and make a practically bloodless amputation.

3. The disarticulation is simpler and quicker than resection of the bone, and there is less danger of wounding important vessels.

4. The suprascapular and posterior scapular vessels, the only other vessels that can bleed, are easily picked up before being cut.

FIG. 1391.—Lynn Thomas' forceps-tourniquet. (*Thomas.*)

5. In malignant growths, where the outer end of the clavicle is involved, there is more hope of a radical cure if the entire bone with its periosteum is removed.

6. It removes everything in one piece, a more surgical procedure when dealing with malignant growths.

Cinematic or Cineplastic Amputations.—Vanghetti's Amputation.—Vanghetti's experiments on birds show that if a tendon or muscle is separated from its insertion and some inches of its distal end are mobilized and covered with skin, the muscle retains its power of voluntary contraction. If the distal end

of the tendon (covered with skin) is formed into a loop or into a knob (*e.g.*, by being tied as a knot) then it is possible to attach a hook or a string to it, and by means of that hook or string to convey the power, provided by the muscle contracting, to a proper artificial limb. These were remarkable experiments to be made by a country practitioner without hospital connections. Unfortunately Vanghetti's original articles are not accessible to the writer.

The method of application devised by Vanghetti is somewhat as follows: In performing an amputation preserve as great a length as possible of any healthy tendons or muscles distal to the line of section of the bone. Form the ends of these tendons (*a*) into loops either by suturing the extemities of two tendons together, or by folding the extremity of one tendon on itself and fixing it as a loop by means of a suture; (*b*) into a knob by tying the end of the tendon into a knot. In the case of a muscle or even a tendon, instead of being divided, a portion of its bony insertion may be chiselled off its bed and left attached to the tendon or muscle as a knob. Envelop the mobilized tendon or muscle (including the loop or knob at its end) with a flap of skin. If a loop is used perforate the skin so as to pass a smooth hook (as an ear-ring) through the loop and by means of this hook and a proper splint keep up enough tension on the tendon to prevent secondary contraction. If the tendon is fashioned as a knob it is unnecessary to perforate the skin, a padded ring may be made to lie around the skin-covered tendon proximal to the knob, and by means of this ring the necessary tension may be kept up. De Francesco ("Archiv für klin. Chir.," lxxxvii, p. 571) carried out Vanghetti's ideas in the case of a man who had undergone amputation in the middle of the forearm five years previously. The muscles in the stump retain their electric irritability and could be contracted voluntarily.

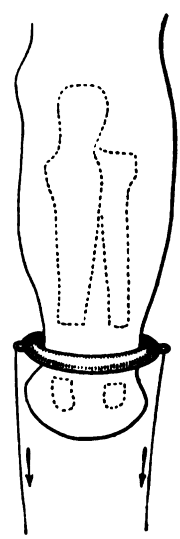

FIG. 1392.—Cinematic apparatus.

De Francesco made a longitudinal incision on each side of the forearm and through them exposed the radius and ulna from a point about ¾ inch proximal to their distal ends, upwards for about 2 inches (5 cm.) (Fig. 1392). He divided the bones ¾ inch from their distal end and at points 2 inches higher, thus removing about 1 inch of each bone. When healing took place, a padded ring was applied around the stump just above the two fragments of radius and ulna, and after a little practice the patient was able to voluntarily flex the fingers of an artificial hand by means of cords attached to the padded ring. The power was obtained by the flexors and extensors pulling upward the knobby stump and with it the padded ring (Fig. 1393 shows De Francesco's patient enjoying himself).

Vrédène (Roussky Bratch., ref. "Journ. de Chir.," i, No. 2) used Vanghetti's method successfully in a case of amputation of the hand just in front of the carpus. The superficial flexor tendons of the hand, exposed through an incision

in the lower part of the forearm, were divided transversely at the lower part the wound, and their proximal stumps sutured to the deep flexors (Fig. 1394).

The tendon loop can readily be enveloped in skin flaps, the pedicles of whi

Fig. 1393.—Result of cinematic amputation. (*De Francesco.*)

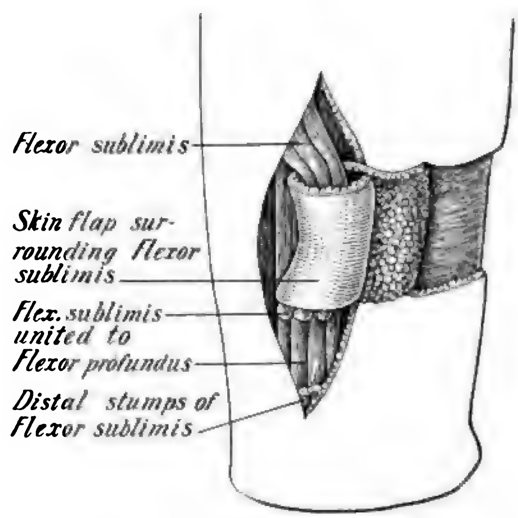

Fig. 1394.—Cinematic amputation.

may be divided after the lapse of about two weeks. In Vrédène's case exerc were begun after about one month, and the tendon loop was able to exert a of 12 pounds. An artificial hand was constructed and its movable thumb, mi

and index fingers could be flexed by means of the tendon loop to which they were connected by a metallic hook. The patient was able to seize and hold various objects.

In the above description the tendons of the flexor profundus are not divided, but probably their division below their union with the flexor sublimis would give greater mobility.

Cinematic amputations have lost much of their desirability since Carnes devised his artificial arms, by the use of which the author has seen a man, who had lost both arms, pick coins off the floor, light his cigar with matches, shave himself and carry a heavy suit-case. One patient whose arm was amputated above the elbow by the author, drives his own electric motor car.

AMPUTATIONS AND DISARTICULATIONS OF THE LOWER EXTREMITY

Amputations and Disarticulations of the Toes.—These are carried out exactly as in the case of the fingers. When the great toe is disarticulated at the metatarso-phalangeal joint, remember that the great size of the head of the metatarsal bone requires large flaps to cover it and that in the presence of articular suppuration the sesamoid bones ought to be removed.

König writes: "When operating for injury or disease of the anterior part of the foot, and it is in any way possible to retain the tarso-metatarsal articulations, limit operation to amputation through the metatarsus. A sufficiency of material must be present since the stump must be covered by a plantar flap and the scar must be dorsal. The amputation is performed exactly like Lisfranc's disarticulation except that the metatarsi are divided. We have often remarked that too great conservatism is out of place in the foot. Thus it is questionable if it makes much difference to the patient whether the metatarsus hallucis is amputated or exarticulated. The removal of the two middle metatarsi makes little difference to the patient, but transverse amputation is always better than the removal of three metatarsi."

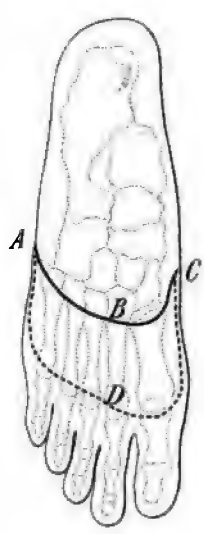

FIG. 1395.—Lisfranc's amputation.

Tarso-metatarsal Disarticulation.—Lisfranc's Amputation.—*Step* 1.—Put the foot in a position of plantar flexion. Note the base of the first and of the fifth metatarsal bone (Fig. 1395). On the *dorsum* of the foot make the incision A B C down to the bone and reflect *all* the soft parts so as to expose the tarso-metatarsal articulations freely.

Step 2.—Put the foot in a position of dorsal flexion. On the *sole* of the foot make the incision A D C and reflect all the soft parts in one long plantar flap until the articulations are exposed.

Step 3.—Hold the foot in a position of marked plantar flexion. Retract

both flaps, being specially careful of the plantar flap. Carry the knife (strong and narrow-bladed) round the base of the fifth metatarsal, then cut forward and inward to open the joints of the three outer metatarsals. Next open the joint between the first metatarsal and the internal cuneiform. Holding the knife firmly, insert it between the first two metatarsals and carry it backwards and forwards in the long axis of the limb (Fig. 1396). Do the same between the second and third metatarsals. Open the joint between the second metatarsal and

Fig. 1396.—Lisfranc's amputation. [illegible]

the middle cuneiform. Complete the disarticulation. Jacobson wisely writes: "The method by disarticulation may be a useful test of a candidate's knowledge and skill at an examination. In practice, sawing through the metatarsals just below their bases may nearly always be substituted, as giving equally good results with a great saving of time and trouble."

Step 4.—Attend to hemostasis. Close the wound with sutures. Dress.

The great objection of Lisfranc's operation is that the projection of the internal cuneiform and scaphoid bones makes a stump which is likely to be painful.

Hey's Amputation.—The author has no experience with the operation, but Estes recommends it as much preferable to Lisfranc's. Barker thus describes Hey's amputation: "Position of Patient: Supine, with the legs brought well over the end of the table, the affected limb being flexed, and resting on its heel on the edge of the table. The surgeon stands facing the patient; an assistant steadies the flexed limb, on the outside of which he stands facing the operator.

Landmarks for Incision and Operation.—The bases of the first and fifth metatarsal bones are the guide for the first incision, which passes with a good downward curve from one to the other, across the dorsum of the foot, forming a flap which should reach well over the metatarsus and contain all the soft tissues. When this is turned up the operator separates the metatarsus from the tarsus by forcibly bearing upon the former while the heel rests on the table, and dividing the tense ligaments, remembering the deep setting of the second metatarsal bone.

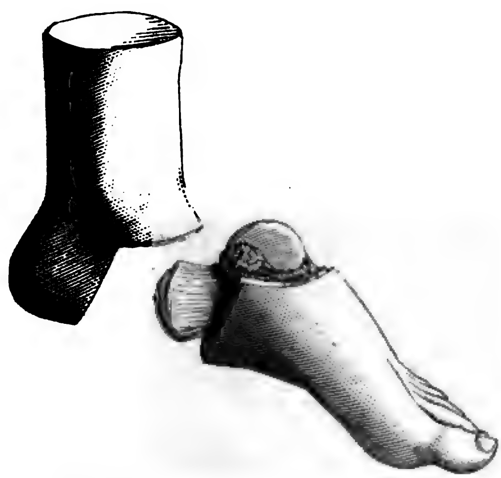

FIG. 1397.—Syme's amputation. (*Farabeuf.*)

The knife is placed transversely behind the metatarsus as the latter is drawn forward by the surgeon's left thumb, and is made to cut downward to the roots of the toes. The long plantar flap thus formed is now cut across, either from side to side or by transfixion from its centre, first on one side, then on the other, the knife being held vertically in each case. It should be a little longer on its inner than on its outer side. Some operators prefer to fashion the plantar flap before separating the bones. Others again recommend cutting through the base of the second metatarsal bone with a bone-forceps to avoid the trouble of disarticulating it; or, again, division of all the bones straight across with a saw just below their bases. In amputation for injury the latter method gives excellent results, where the treatment is distinctly aseptic."

Syme's Amputation.—*Step* 1.—Make an incision down to the bone from the tip of the external malleolus to a point ½ inch below the internal malleolus. This incision goes across the sole, but its centre is slightly curved toward the

heel (Fig. 1397). Unite the upper ends of this incision by a cut straight across the front of the ankle-joint.

Step 2.—Bend the foot downwards so as to put much tension on the lateral ligaments of the ankle. Open the joint freely and divide the lateral ligaments. When cutting the soft parts on the inner side of the ankle be careful to cut the posterior tibial artery low down because of its importance in nourishing the flaps.

Step 3.—By bending the foot more and more, separate the surfaces of the ankle-joint and expose the tendo Achillis. Divide the tendo Achillis close to the os calcis. Dissect the heel flap from the os calcis from above downwards, leaving the flap as thick as possible and *not* punctured. In children the epiphy-

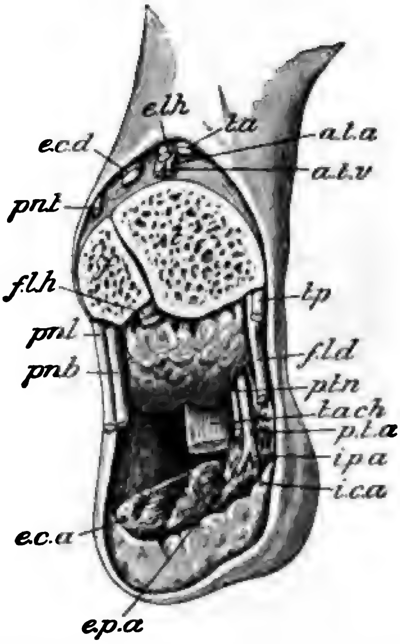

FIG. 1398.—Syme's amputation. (*Walsham.*)

f, Fibula; *t*, tibia; *t.a*, tibialis anticus; *elh*, ext. long. hallucis; *a.t.a*, ant. tib. art.; *a.t.v*, ant. tib. vein; *e.c.d*, ext. com. dig.; *pnl*., peroneus longus; *pnb*., peroneus brevis; *f.l.h*, flex. long. hallucis; *t.ach*, t. achillis; *t.p*, tib. post; *f.l.d*., flex. long. dig; *p.t.a*. post, tib. art., dividing into *e.p.a*. and *i.p.a*., external and internal plantar artery; *e.c.a*. and *i.c.a*, ext. and int. calcaneal branches forming blood supply of thick heel-flap.

sis may come away with the heel flap and if healthy can be utilized. Remove the foot (Fig. 1398).

Step 4.—With the saw remove both malleoli and with them a very thin slice of tibia. As an alternative remove the malleoli alone (Macleod).

Step 5.—Trim away any excess of tendons or other tissue. Attend to hemostasis. Close the wound.

Watson's Amputation ("Brit. Journ. Surg.," ii, 390).—***Step*** **1.—With** knife mark the skin at the following points: (*a*) ½ inch below and behind the tip of the internal malleolus; (*b*) ¼ inch below the tip of the external malleolus; (*c*) 1½ inches distal to the midpoint of a line joining the malleoli anteriorly. Join these points by a curving incision and reflect upwards the flap as far as the

ankle-joint. Divide the extensor tendons and anterior tibial vessels. Divide and cut short the anterior tibial and musculo-cutaneous nerves. Open the ankle-joint and forcibly put the foot in the equinus position. Cutting close to the bone divide the internal lateral ligament and the anterior and middle fasciculi of the external lateral ligament. Pass the knife between the astragalus and os calcis and divide the interosseous ligament. Open the astragalo-scaphoid joint and free the head of the astragalus. With strong forceps twist the astragalus from the posterior ligament of the ankle and from the posterior fasciculus of the external lateral ligament.

Step 2.—With a broad gouge or chisel remove the cartilage from the lower ends of the tibia and fibula and from the upper surface of the os calcis. Cut away the sustentaculum tali. Remove the soft structures from the sinus pedi. Subcutaneously divide the tendo Achillis and any contracted fibrous tissue around it.

Step 3.—From the ends of the primary dorsal incision make a cut which reaches to half an inch in front of the tubercle of the scaphoid on the inner side and the same distance in front of the base of the fifth metatarsal bone on the outer side; the cut curves across the sole between these two points. Disarticulate the os calcis from the cuboid and complete the separation of the foot by cutting from behind forwards obliquely, through the soft parts of the sole to the margin of the skin flap, keep the knife as close to the bone as possible. Remove the anterior articular surface of the os calcis. Attend to hemostasis. Cut the nerves short.

Step 4.—Wedge the os calcis between the malleoli and nail it there by means of a 6-inch steel pin driven through the centre of the heel, through the os calcis and into the center of the tibial shaft. Leave the end of the pin projecting through the skin. If any tension remains about the tendo Achillis relieve it by subcutaneous section but do not injure the posterior tibial vessels. Suture the flaps. Insert a small drain. After two days remove the drain. After 2 weeks remove the pin. Immobilize for about 6 weeks to permit of bony union. The advantages claimed for Watson's amputation are: The original heel pad covers the stump. The retained malleoli give a firm hold to the uppers of ordinary high shoes. There is only about one inch shortening of the limb. No artificial limb is required; an ordinary high shoe can be worn if the sole is stiffened with metal and a block is used to fill the toe space.

Roux's Operation.—This is identical with Symes's except that the flap is *not* made over the heel but on the inner side (Fig. 1399).

Pirogoff's Amputation.—*Steps* 1 and 2 as in Syme's amputation.

Step 3.—Make strong plantar flexion until the astragalus is dislocated forwards and the upper surface of the posterior part of the os calcis comes into view. With the saw divide the os calcis vertically immediately behind its articular surface (Figs. 1400 and 1401).

Step 4.—Remove the malleoli and a thin slice of the tibia as in Syme's operation.

Step 5.—Divide the tendo Achillis at its insertion.

Step 6.—Complete the operation as in Syme's.

The sawn surface of the posterior end of the os calcis unites to the tibia, giving a good stump.

Pirogoff's operation is very difficult to perform, and accidents in healing may lead to distortion of the stump.

Fig. 1399.—Roux's amputation. (*Stimson.*)

Le Fort's Operation, a modification of Pirogoff's, is sufficiently explained by figure 1402. The incision crossing the sole lies at the posterior margin of the navicular bone.

Amputation of the Leg.—The paragraphs devoted to amputating in general describe sufficiently the usual methods of removing the leg.

It may be remarked that the ventral decubitus presents some marked advantages over the usual dorsal position in amputations below the knee in that

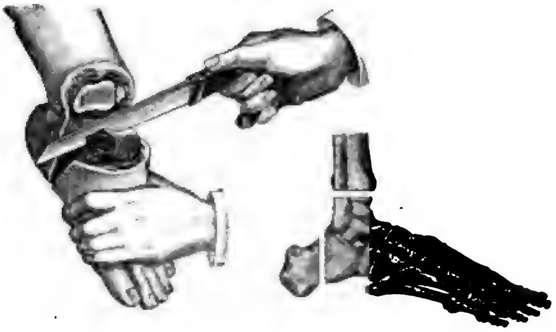

Fig. 1400. Fig. 1401.

Figs. 1400 and 1401.—Pirogoff's amputation. (*Esmarch and Kowalzig.*)

Fig. 1402.

Fig. 1402.—Le Fort's amputation (*Esmarch and Kowalzig.*)

flexion of the knee permits the easiest possible access to the territory of operation (Finochietto, "Annals Surg.," May, 1915).

Osteoplastic Amputations.—Osteoplastic amputations are less serviceable after trauma than after disease.

Bier.—Osteoplastic Amputation Leg.—Bier's operation may be carried out either on the basis of a circular or a flap amputation. The circular method will be here described.

Step 1.—Make the usual circular incision through the skin and subcutaneous tissue, being specially careful *not* to injure the periosteum. Reflect a cuff of skin upwards (Fig. 1403).

Step 2.—With a knife trace out a periosteal flap with its pedicle above, on the free surface of the tibia. With a fine saw or chisel (the chisel is liable to splinter the bone) separate a shell of bone from the tibia so that a flap is formed consisting of periosteum and bone. The shell of bone ought to be long enough to cover the cut surface of the tiba and the fibula (Bier's method) after the limb is amputated, or to cover the cut surface of the tibia alone (Kocher). When sufficient bone has been cut away or shaved off the tibia continue the separation of the periosteal flap from the tibia upwards to the line where the bone must be divided (Fig. 1403). Complete the amputation.

Step 3.—Turn the periosteal-bone flap so as to cover the sawn ends of the tibia and fibula or of the tibia alone with the shell of bone (Fig. 1404). Fix it in position with a few sutures.

Step 4.—Attend to hemostasis. Close the wound.

This operation gives a very excellent stump.

Bier's method may be modified in various ways, one of the principal modifications being to construct a flap of skin, periosteum and a shell of bone instead of periosteum and bone alone.

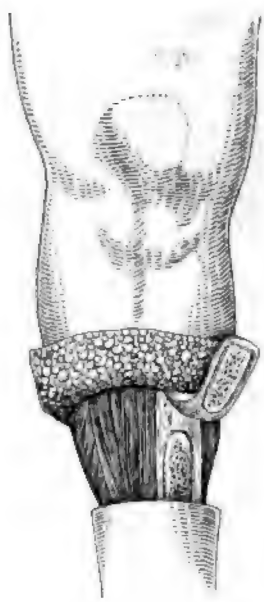

FIG. 1403.

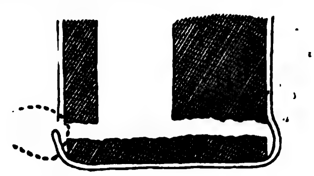

FIG. 1404.

FIGS. 1403 AND 1404.—Bier's osteoplastic amputation.

Figures 1405, 1406, 1407, 1408, from Trzebicky and Frommer's article "Archiv für klin. Chir.," lxx, 472), illustrate this method admirably. Note in Fig. 1408 that a segment of bone is removed at the base of the bone flap; this is, of course, to permit the folding over of the flap. Figure 1409 shows the application of the same principle in amputation of the thigh.

Haffter's Osteoplastic Amputation of the Leg.—Dumont describes this operation ("Deutsche Zeitschrift für Chir.," xcii, 497).

Step 1.—Make an obliquely oval incision through the skin. On the *outer* side of the limb the incision is at a much lower level than on the *inner* side.

Step 2.—On the inner side retract the skin upwards in the usual manner and

FIG. 1399.—Roux's amputation. (*Stimson.*)

Le Fort's Operation, a modification of Pirogoff's, is suffici
figure 1402. The incision crossing the sole lies at the **poste**
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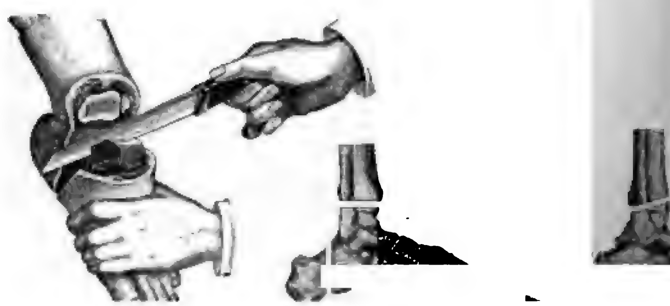


face of the tibia. Vivify the surface of the fibula apposed to the tibia. Attend to hemostasis. Close the wound with deep and superficial sutures in such

FIG. 1409.—Osteoplastic amputation. (*Trzebicky and Frommer.*)

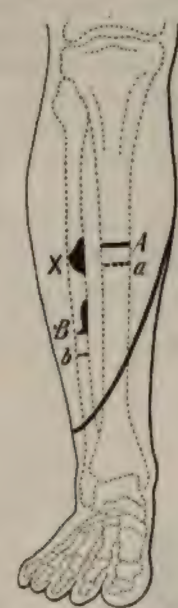


FIG. 1410.—Hafter's osteoplastic amputation.

a manner that the mobilized portion of fibula is left in contact with the end of the tibia. Excellent results have been obtained by this operation which seems simple and sensible.

Author's Amputation.—In performing Bier's osteoplastic amputation the author has been struck by its difficulty and by the ease with which the plate of bone falls off the periosteal flap at the last moment. Little or no nourishment can reach the bone fragment through the periosteum which really acts merely as a hinge; he therefore operates as follows:

1. Reflect the soft parts by the circular or flap method but leave the periosteum intact.

2. Transversely divide the periosteum of the tibia along two lines separated from each other by a space about ½ inch greater than the diameter of the bone (Fig. 1411).

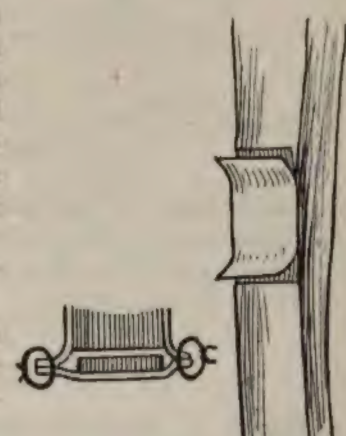


FIG. 1411.

From the upper incision separate the periosteum downwards for about ¼ inch. From the lower incision separate the periosteum upwards for about ¼ inch. With a saw cut through the compact bone transversely near the base of the peri-

osteal flaps. With an osteotome cut free the plate of bone between the two saw cuts. This plate of bone is covered by periosteum which hangs over its upper and lower edges like a table cloth. Preserve the plate of bone in warm salt solution or in gauze moistened with salt solution.

3. Choose the line of bone section and after forming a periosteal cuff divide the bone. Attend to hemostasis.

4. Place the plate of bone over the cut surface of the tibial stump (raw surface to raw surface) and suture the periosteum of the plate to the periosteum of the tibia.

5. Close the wound *secundum artem.*

In amputation of the thigh Hayden suggests using the patella, after shaving off its articular surface, as a free transplant to cover the divided end of the femur.

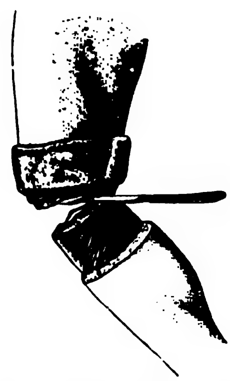


FIG. 1412.
(*Esmarch and Kowalzig.*)

FIG. 1413.
(*Farabeuf.*)

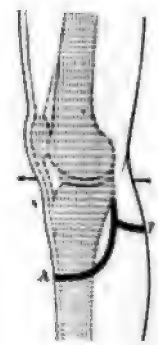


FIG. 1414.
(*Farabeuf.*)
The distance from the joint to A is equal to the diameter of the leg. The distance of P from the joint is one-half the diameter of the leg.

FIGS. 1412, 1413 AND 1414.—Disarticulation of knee.

Disarticulation at the Knee.—The ordinary methods of disarticulation of the knee require no special description. They are performed by the circular (Fig. 1412), oval (Fig. 1413), or flap (Fig. 1414) methods. The patella may or may not be removed.

AMPUTATION BESIDE THE KNEE

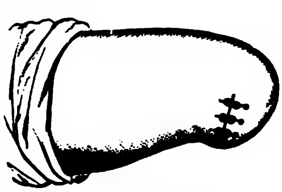
Method A.—Carden's Intra-condyloid Amputation.—Make the skin incision shown in Figs. 1415 and 1416. Reflect the anterior skin flap upwards in front of the patella and expose the upper edge of that bone. Divide the quadriceps extensor at its insertion. Divide the ham-strings and the contents of the popliteal space. Clear the femur immediately above the articular

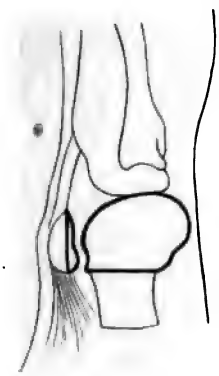
cartilage and divide the femur at this level in such a manner as to give a horizontal surface for the patient to rest on. It must be noted, however, that the soft parts posterior to the knee contract after section, while those anterior do not

FIG. 1415.—Carden's amputation. (*Moullin.*)

do so, hence a circular flap becomes an oval one on account of the posterior contraction.

Method B.—Gritti's Osteoplastic Operation.—Make the same skin incision as in Method A, *but* turn up the patella in the anterior flap. Saw off the articular





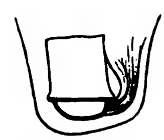
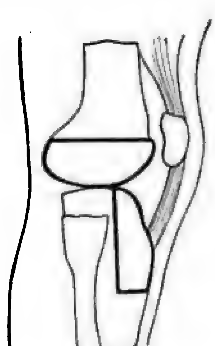


FIG. 1416. FIG. 1417. FIG. 1418.

FIG. 1416.—Carden's amputation. (*Moullin.*)
FIGS. 1417 AND 1418.—Gritti's osteoplastic amputation. (*Stewart.*)



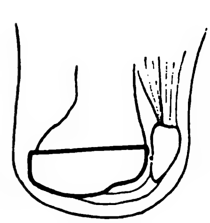


FIG. 1419. FIG. 1420.

FIGS. 1419 AND 1420.—Sabanejeff's osteoplastic amputation. (*Stewart.*)

surface of the patella (Figs. 1417 and 1418). Complete the amputation. Place the sawn surface of the patella (in the anterior flap) against the cut surface of the femur. Close the wound.

Method C.—Sabanejeff's Method.—Make an anterior flap similar to Carden's but having its lowest point below the patellar tubercle. With saw or chisel cut off, in one piece with the skin flap, a portion of the anterior superior surface of the tibia (Figs. 1419 and 1420). Complete the amputation. In closing the wound place the bone in the anterior flap in contact with the divided end of the femur. Both Gritti's and Sabenejeff's methods are valuable.

Amputations of the thigh do not require special description.

AMPUTATION OR DISARTICULATION AT THE HIP

Method of Temporary Hemostasis.—1. Preliminary ligation of external iliac artery.

2. Compression of common iliac artery through an abdominal incision (McBurney, "Annals Surg.," 1894, ii, 181).

3. Preliminary ligation of femoral vessels (a) through a special incision; (b) at an early stage in the "anterior racquet" operation.

4. (a) Trendelenburg's pin.
   (b) Varick's modification of Trendelenburg's pin.
   (c) Thomas' forceps.
   (d) Wyeth's pins.
5. Jordan-Lloyd's tourniquet.
6. Digital compression.
7. Macewen's method of aortic compression.
8. Momburg's method.
9. Senn's method.

Trendelenburg's Pin.—The pin or rod is of steel, 15 to 16 inches long, 1/4 inch wide and 1/12 inch thick in the centre. The original pin was provided with a removable lance-shaped point 2 inches in length. Wyeth's pins would answer the purpose. Introduce the pin 1 1/2 inches below the anterior superior iliac spine, make it pass in front of and touching the femur to emerge at the posterior scroto-femoral junction. Remove the point or protect it with a cork. Aided by the pin it is easy to apply a rubber tube in the figure-8 fashion so as to compress all the soft structures in front of the hip, between the pin and the rubber tube. Trendelenburg operated by transfixing about 1/2 inch below the pin, cutting a long anterior flap, ligating the vessels, removing the pin, disarticulating the joint, and, lastly, making the posterior flap.

Varick ("Bryant's Op. Surg.") did not disarticulate until he had transfixed a second time behind the neck of the femur.

Thomas' Forceps.—Lynn Thomas has devised a long forceps, very like a gastrectomy clamp, one blade of which is passed through the tissues exactly like Trendelenburg's pin; the other blade pressing on the tissues externally takes the place of the rubber tube. This forceps did yeoman service in the Boer war and is a thoroughly practical device (Fig. 1421).

Wyeth's Pins.—Provide two mattress pins each one foot long and 3/16 inch thick. The point should be bayonet-shaped. Insert one pin 1/4 inch

below, and slightly internal to, the anterior superior spine; make it pass somewhat superficially through the tissues at the outer side of the hip to emerge on a level with the point of entrance. Insert the other pin through the adductor

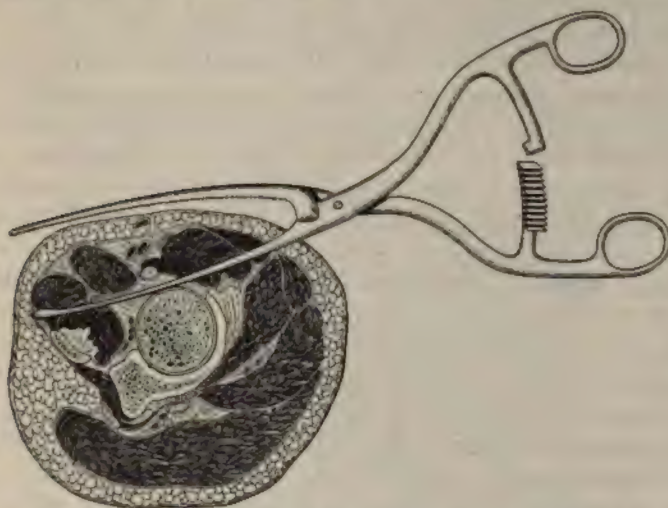


FIG. 1421.—Lynn Thomas' forceps-tourniquet. (*Thomas.*)

longus ½ inch below the perineum, to emerge 1 inch below the ischial tuberosity (Fig. 1422). Protect the points of the pins with corks. Apply a rubber tube tightly around the limb above the pins. The pins prevent the rubber tube

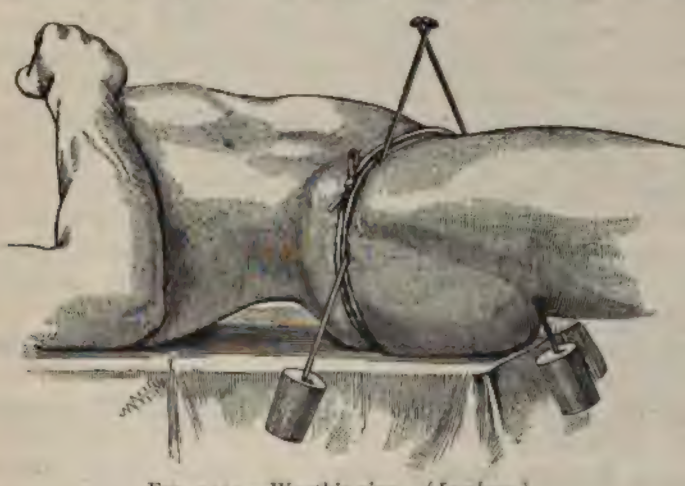


FIG. 1422.—Wyeth's pins. (*Jacobson.*)

from slipping even after the joint is disarticulated and the limb removed. The author has found this method very satisfactory.

Jordan Lloyd's Tourniquet or Elastic Constrictor.—Double a two-yard piece of stout rubber bandage. Pass it between the thighs so that its middle

lies between the ischial tuberosity of the side to be operated on and the anus. Lay a common roller bandage (size for the thigh) lengthwise over the external iliac artery. Pull the ends of the rubber bandage upwards and outwards, one in front and one behind, to a point above the centre of the iliac crest of the same side. There must be no pulsation in the femoral and tibial arteries when the band is in position. The front part of the rubber band runs parallel to and just above Poupart's ligament and, by means of the roller bandage, compresses the external iliac artery. The posterior part of the rubber band crosses the great sacro-sciatic notch and controls the branches of the internal iliac. The ends of the bandage may be held by an assistant or secured as a figure 8 round the body. This method has not the safety of those of Wyeth or Thomas.

Digital compression of the femoral artery is unsatisfactory.

Macewen's Method.—Compression of the Aorta.—Arrange the patient exactly as he is to lie during the operation. Place a platform or steady stool by the left side of the table of such height that an assistant standing on it can lean over sidewise and with his right elbow fully extended lay his closed fist on the aorta immediately to the left of the umbilicus. The assistant placed as above, facing the patient's feet, stands on his left foot, his right foot crossing the left, leans on his right fist and so compresses the aorta with the minimum of fatigue. The writer can vouch for the simplicity and efficiency of the method; he can also vouch for the fatigue of the assistant at the close of the operation.

Momburg's method of controlling the circulation in the lower half of the body ("Zentralblatt für Chir.," 1908, No. 23) is applicable not merely to operations about the hip-joint, but to interilio-abdominal amputations as well. Apply a rubber tube (as thick as a man's finger), under full tension, two to four times around the waist of the patient between the iliac crest and the lowest ribs. Watch the femoral pulse; as soon as it is no longer palpable, enough constriction has been applied. As soon as the operation is completed, apply an elastic bandage to both limbs from the feet up, if the operation has been on the pelvis, or to the remaining limb if one has been amputated. Elevate the limb. Remove the constrictor from around the waist. Gradually remove the elastic bandage from the limb so as to permit the circulation to be resumed by degrees in the lower part of the body lest too great a strain be suddenly put on the heart. Bier, Axhausen, and others have used Momburg's method with success and satisfaction.

The methods of performing amputation or disarticulation at the hip-joint are innumerable, only a few will be described here.

1. **External Racquet Incision.**—This operation and its modifications are practically identical with

Furneaux Jordan's Method.—Place the patient on his back with the buttocks resting on the extreme end of the table. Let the assistant hold the leg and manipulate the limb according to instructions. If desired, provide for temporary hemostasis. Slightly adduct, flex and rotate the thigh inwards.

Step 1.—Make a longitudinal incision from a point about 2 inches above to a point about 6 inches below the tip of the trochanter major. This incision

runs along the femur near the posterior edge of the trochanter and penetrates at once to the bone (Fig. 1423).

Step 2.—With a stout knife divide the muscular attachments of the trochanter major and expose the joint. Before dividing the muscular attachments it may be well, in certain cases, to expose, open, and explore the joint so that the alternative of reaction may be adopted instead of amputation, under proper circumstances.

With periosteal elevator, stout knife or scissors separate the soft parts from the femur (most difficult at the trochanter minor and the linea aspera) for the full length of the longitudinal wound.

Step 3.—**Method A.—Senn's Method.**—Dislocate the head of the femur and make it protrude through the wound. Introduce a closed forceps through the wound and force it through the tissues on the inner side of the thigh so as to make a prominence on the skin. Divide the skin over the point of the forceps and grasp in its blades the middle of a length of rubber tubing. Pull the tubing through the wound and divide the tube where it was grasped by the forceps, thus leaving two portions of elastic tubing passing completely through the thigh. Tie one of these tubes tightly around the anterior, the other round the posterior mass of tissues. This insures hemostasis during the completion of the amputation.

FIG. 1423.—Jordan's operation. (*Bryant.*)

Method B.—Dislocate the head of the femur and make it protrude through the wound. Pass *one* blade of a Thomas's clamp (a gastrectomy clamp will do) through the wound and make it perforate the skin on the inner side of the thigh. Let the other blade of the clamp pass over the front of the thigh. Tighten the clamp. This insures hemostasis in the anterior flap where the principal vessels lie. If desired, a similar forceps may be applied to the posterior side of the thigh, or the soft parts of the anterior side may be divided, the vessels secured and then the same forceps applied to the posterior tissues, which may be divided in turn. This method of using forceps (Thomas) seems very practical.

Method C.—From the lower end of the vertical incision make a circular or oblique incision through the skin and subcutaneous tissues completely round the thigh at a distance of 6 to 8 inches from the tip of the trochanter. Dissect the skin upwards for about 2 inches; at this level divide the muscles and remove the limb. As soon as the muscles are divided the vessels must be secured. This method is identical with the two preceding ones except in the matter of hemostasis.

Step 4.—The limb having been removed, attend to final hemostasis. Inspect the acetabulum for disease and treat such disease if found. Close the wound after providing for drainage.

Remark.—The racquet-shaped incision provides a wound which lies as remote as possible from the nates and genitalia.

2. **Wyeth's Amputation.**—Introduce Wyeth's pins (p. 1204). Apply elastic constrictor above the pins.

Step 1.—Make a circular incision around the thigh about 2 to 2½ inches below the lesser trochanter, dividing the skin and subcutaneous tissues alone. Reflect the skin upwards to the level of the lesser trochanter. At this level divide the muscles circularly to the bone.

Step 2.—Make a vertical incision over the line of the external surface of the femur from the elastic constrictor to the circular incision. Ligate all the principal vessels in the wound.

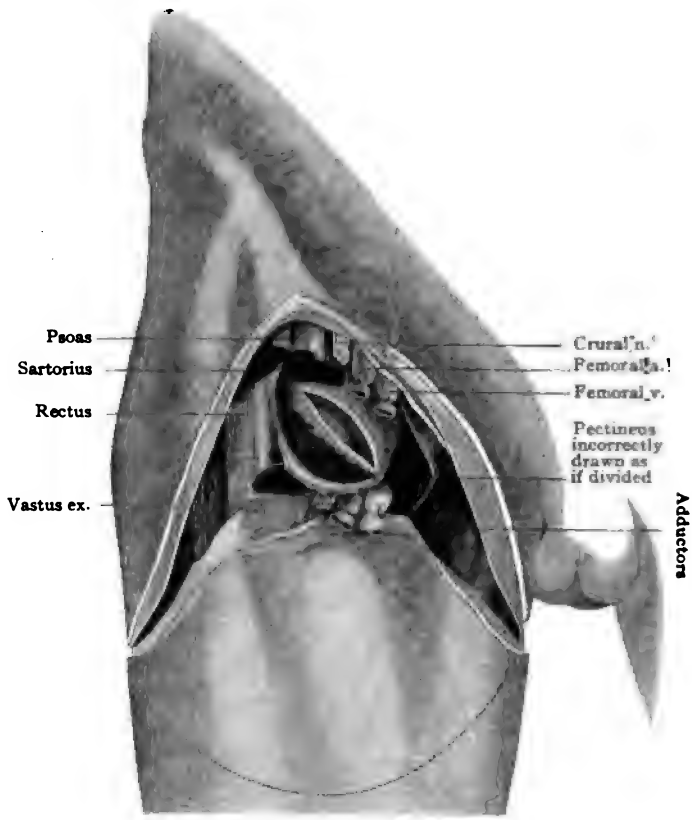


FIG. 1424.—Kocher's amputation. (*Kocher.*)

Step 3.—Separate all the soft parts from the femur upwards from the circular incision. Disarticulate the hip. To accomplish disarticulation divide the capsular ligament, make a notch in the cotyloid ligament to permit air to enter the joint, manipulate the limb to expose the ligamentum teres, divide this ligament, complete the dislocation by manipulation, using the limb as a lever. Some surgeons divide the femur as soon as they make the circular division of the muscles; the loss of the limb as a lever makes disarticulation of the joint needlessly difficult.

Step 4.—Remove the limb. If any vessels are visible, ligate them. Remove the elastic constrictor or pins. Attend to hemostasis. Provide for drainage. Close the wound. Apply dressings. Wyeth's operation has given great satisfaction to all who have used it. It is very easy and safe.

3. **Anterior Racquet Incision.**—This method is convenient because at the very beginning of the operation the femoral vessels are exposed, doubly ligated and divided. The incision encircling the limb in an oblique fashion may be so arranged as to form two practically equal flaps, one long external flap, one long internal flap, two unequal lateral flaps or one long posterior flap. This freedom of choice in obtaining material to cover the stump is of importance, as the site of disease and skin involvement may render it necessary to remove much skin and soft structures. The anterior racquet method is entirely analogous to the removal of a tumor from the body, in this case the limb being considered as tumor.

Step 1.—From a point immediately below the centre of Poupart's ligament make a vertical incision downwards for 3 to 4 inches. Expose, doubly ligate, and divide the common femoral artery and vein. Divide the crural nerve (Fig. 1424).

Step 2.—At the lower end of the vertical incision make an obliquely circular cut all round the limb, dividing the skin and subcutaneous tissues. Reflect the skin upward for about 2 inches, and divide the muscles at this level. Any vessels divided (obturator, superior, and inferior gluteals) must be caught in hemostats.

Step 3.—Separate from the bone any soft structures still attached, and remove the limb by disarticulation.

Step 4.—Attend to hemostasis. Provide for drainage. Close the wound. Dress.

The operation as above described is suitable in many cases, but the remote results of disarticulation of the hip for sarcoma of the femur cannot be described by any milder term than vile. This is due to the fact that the sarcoma early involves the soft parts—for instance, the muscles—and of these principally the adductors (Quénu et Desmarest, "Rev. de Chir.," 1903, No. 5). Given a patient with fair vitality, one should therefore modify Step 2 of the anterior racquet method so as to expose and divide the muscles at their pelvic origin.

The author suggests the following method of disarticulation of the hip as being theoretically suitable in sarcoma of the femur.

Step 1.—Through a muscle-splitting incision expose the common iliac artery preferably extraperitoneally. Apply to the vessel Crile's clamp or a temporary ligature. Pack and protect the wound, if necessary using a stitch or a small volsellum forceps to temporarily close the wound. Instead of the above method, Momburg's elastic constrictor may be employed (p. 1206).

Step 2.—Make a vertical incision below Poupart's ligament; expose, doubly ligate, and divide the femoral vessels. Divide the anterior crural nerve.

Step 3.—Beginning at the lower end of the vertical incision trace out and reflect flaps of skin and subcutaneous tissues sufficient to cover the wound which will be left by the operation. These flaps of skin and subcutaneous tissues must

be reflected up to the crest of the ilium, the rami of the pubis and ischium, the ischial tuberosity, etc., etc., so that the muscles connecting the femur to the trunk are completely exposed, except of course those coming from inside the belly.

Step 4.—Separate the muscles from the pelvis at or very near their origin and dissect them downwards until the hip-joint is exposed all around. Divide the muscles coming to the femur from inside the pelvis; these cannot be excised.

Step 5.—Disarticulate. Remove the limb.

Step 6.—The femoral vessels have already been ligated. Look out for and ligate the gluteal and sciatic vessels (Fig. 1425). Pick up and ligate all visible vessels. Pack the huge wound with gauze wrung out of very hot water.

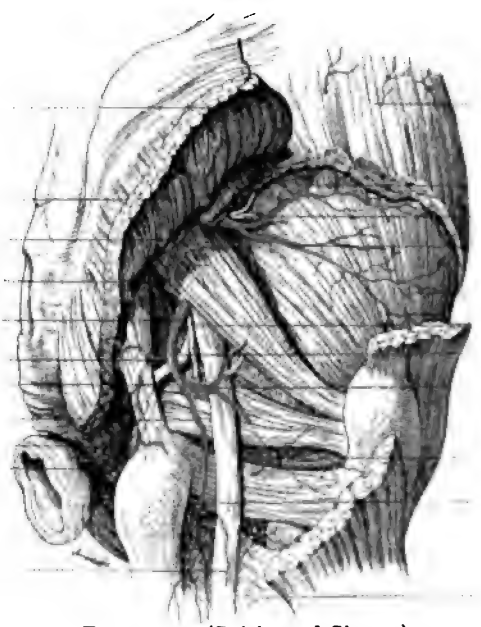


FIG. 1425.—(*Poirier and Charpy.*)

Step 7.—Reopen the abdominal wound. Let a competent assistant remove the Crile's clamp and hold himself ready to compress the iliac if necessary. Review the amputation wound. Arrest all hemorrhage. Provide for drainage. Close the wound.

Step 8.—Close the abdominal wound. Apply dressings.

Felix Franke ("Zentralblatt für Chir.," 1897, No. 45, and 1913, No. 3) note that after disarticulation the acetabulum forms a cavity which may interfere with healing; therefore in suitable cases he advocates amputation through the neck of the femur, leaving the head of the bone to fill the cavity.

Interilio-abdominal Amputation (Jaboulay's Operation).—*Step* 1.—Beginning at the symphysis of the pubis, make an incision parallel to and below Poupart's ligament. Continue the incision the whole length of the crest of

the ilium. Expose the peritoneum without opening it and separate it by gauze dissection from the underlying structures until the common iliac vessels are exposed. Doubly ligate and divide the common iliac artery. Do the same to the external iliac vein.

Step 2.—Make a circular incision through the skin and subcutaneous tissues completely round the thigh at the junction of its middle and upper thirds. From a point in the middle line of the anterior surface of the thigh make an incision upwards and inwards reaching from the circular incision to the pubis. From the same point make a similar incision up to the anterior superior spine. These two cuts meeting the cut made in Step 1 surround a triangle of tissue which must be sacrificed, and outline a very large posterior, cuff-like flap. Reflect the cuff-like flap of skin and subcutaneous tissue so as to expose the whole base of the thigh and its pelvic connections.

Step 3.—Retract the spermatic cord (or round ligament) inwards and upwards. Separate the rectus and pyramidal muscles from the pubis on the affected side. With a stout knife divide the symphysis. Separate the corpus cavernosum and the muscles and fascia from the ischio-pubic rami. Abduct the thigh forcibly so as to make the symphysis gape. Separate from the bone the soft structures arising from the inner surface of the ilium, as the thigh is more and more abducted. If these structures are involved remove them also. Divide the psoas. Expose and divide the sacro-iliac articulation from within outwards. Divide the structures emerging through the sciatic notches. When this is done it is easy to remove the limb and corresponding portion of the pelvis.

Step 4.—After reviewing the wound, cover it by the large cuff-like flap. Various modifications of the above operation have been attempted. At the best it is a most formidable procedure. If the disease is sarcoma, recurrence is almost sure to take place should the patient survive the operative ordeal. When the operation seems indicated for tuberculous disease of the hip involving the ilium, most surgeons would operate in two or more stages, for instance: (*a*) Amputate or disarticulate at the hip-joint. This *per se* might so increase the resisting power of the patient by removing a great source of absorption that nature might possibly cure the patient. (*b*) At a later stage the surgeon may remove part or all the ilium as may be indicated.

CHAPTER CVII

FLAT-FOOT

When flat-foot is due to rupture of the deltoid ligament and chronic dislocation of the astragalo-navicular joint Katzenstein's operation may be of value (see p. 1081).

Ogston's Operation.—Apply Esmarch's bandage. On the inner side of the foot make an oblique incision in such a manner that the middle of the cut crosses the astragalo-scaphoid articulation. With a periosteal elevator expose those portions of the head of the astragalus and the scaphoid which are contiguous to the joint. With a chisel remove sufficient of these bones (especially of the astragalus) that when their cut surfaces are approximated the sole of the foot is arched in the normal fashion. Ogston maintains the bones in apposition by means of bone pegs; this is perhaps unnecessary. Close the wound without drainage. Dress. Immobilize with plaster of Paris. Place limb in elevated position. Remove Esmarch's bandage. Treat the case as a fracture.

Gleich's Operation.—Gleich in 1893 described his operation of cuneiform osteotomy of the os calcis. Brenner modified the operation in that he advised a mere oblique section of the bone in place of the removal of a wedge. It is Brenner's modification as performed in von Eiselsberg's clinic that is here described. The results have been very good. Riedl reports that 87 per cent. of Brenner's patients are cured, many of them being able to serve in the army.

Step 1.—Apply an elastic constrictor to the thigh. Place the foot and ankle on a sand-bag in such a manner that the *whole* inner (tibial) side of the foot and ankle is imbedded in and steadied by the sand-bag. One finger's breadth behind the external malleolus make an oblique incision down to and through the periosteum of the os calcis. Brenner prefers to operate on the inner side (H. Riedl, "Archiv für Klin. Chir.," xcii, p. 416).

Step 2.—With an osteotome divide the os calcis obliquely from obove downwards and forwards. It is well to use a broadbladed osteotome in order to avoid splintering of the bone and to leave a smooth cut surface. As soon as the bone is divided cut the periosteum on the inner side of the bone. Complete mobility of the posterior fragment of bone is necessary; if it is not mobile some undivided strands of periosteum must be looked for and, when found, cut.

Step 3.—Push the fragment of bone downwards, forwards and a trifle inwards to the desired extent. If valgus is a feature, then the lateral dislocation of the fragment must be more pronounced. The downward displacement should be about ½ to ¾ inch. If the operation has been properly performed the bone ought to tend to stay in its new position.

Step 4.—Hold the bone in position. With a knife or tenotome puncture the skin of the heel over the end of the os calcis. Introduce a drill through the skin

puncture, and fix the fragment of bone in its new position by means of this drill. Brenner does not nail the bone.

Step 5.—Close the wound without drainage. Apply dressings. Leave the drill *in situ*. Immobilize with plaster of Paris in a position of slight supination and plantar flexion. Remove the elastic constrictor.

After about two weeks remove the drill without taking off all the plaster of Paris. About three weeks after operation renew the plaster of Paris so that the patient can move about without risk to the calcaneum. Bony union is generally complete about six weeks after operation. Figure 1426 shows the result in a patient of v. Eiselsberg's two years after operation.

Nicoladoni's Operation.—Paralysis of the gastrocnemius is liable to lead to *talipes cavus*, the arching of the foot being caused by the unrestrained action of the short muscles of the foot. Nicoladoni imagined that if, in severe flat-foot,

FIG. 1426.—Brenner's modification of Gleich's operation. (*v. Eiselsberg.*)

the short muscles were given free play by throwing their antagonists out of action their action would tend to cure the deformity. If the tendo-Achillis is divided and kept temporarily from reuniting the above conditions will be fulfilled. The following is Nicoladoni's operation with a trivial modification by Hertle:

Step 1.—Perform subcutaneous tenotomy of the tendo-Achillis at the classical site.

Step 2.—At a point about $1\frac{1}{2}$ inches higher than the puncture of the tenotome, make a longitudinal incision about 2 inches long along the inner side of the tendon. Separate the tendon from its surroundings and pull its stump out of the wound.

Step 3.—Fold the mobilized tendon upwards and tuck its cut end under the deep fascia of the leg. Fix the cut end of the tendon in position by one or more sutures.

Step 4.—Close the skin wound. Dress. Immobilize for ten days. After about ten days remove all immobilizing apparatus and encourage the patient [illegible] walk. The more exercise is taken the more likely are the muscles concerned [illegible]ity.

It was Nicoladoni's intention to repair the tendo-Achillis after the flat-foot was relieved but neither he nor Hertle have found it necessary. Results are reported to be excellent not only are the pains permanently relieved, but an anatomic correction of the deformity is often obtained. The tendo-Achillis reforms after a time.

Ernst Müller's Operation ("Centralblatt f. Chir.," 1903, p. 40).—In flat-foot, especially when muscles are spastic, the tibialis anticus tendon often stands out like a cord and its site is marked on the skin by a pigmented line. The object of Müller's operation is forcibly to correct the position of the foot and to retain the new position by means of the anterior tibial tendon. In thirteen cases the operation gave satisfactory results.

Step 1.—Tenotomy of tendo Achillis to permit elevation of arch of foot.

Step 2.—From a point below and behind the internal malleolus midway between it and the sole, make a curved incision along the margin of the arch of the sole to the base of the first metatarsal bone.

Step 3.—Find and divide the insertion of the tibialis anticus at the anterior end of the wound. Isolate the tendon up to the ankle.

Step 4.—Expose the plantar surface of the navicular bone and bore a hole, the size of a lead-pencil, through it from below upwards and slightly backwards.

Step 5.—Pull the tendon of the tibialis anticus through this bone tunnel by means of a thread.

Step 6.—Push the arch of the foot forcibly upwards. Pull the tendon strongly down and wind it around the inner margin of the navicular bone. Fix the tendon to the bone or periosteum with wire sutures. Close the wound without drainage. Dress. Immobilize in plaster of Paris for four weeks, after which massage and passive movements are begun. The "flat-foot sole" should be used until there is complete functional recovery.

Eugen Müller ("Brun's Beiträge," lxxxv, 424) writing of Ernst Müller's operation says it is only suitable in severe cases, *e.g.*, those in which there is a complete sinking of the arch when weight is born on the foot. If a flat-foot plate is used, it causes great pain. When the condition is recent the bones involved still preserve their normal shape or are only slightly deformed and they retain their normal mobility. The normal arch can be restored by manipulation when no weight is born on it, and when the ankle-joint is in a position of plantar flexion, *i.e.*, when the tendo Achillis is not stretched. If one tries to bring such a foot to a right angle with the leg or to flex it dorsally the flat-foot immediately recurs, the head of the astragalus and the navicular bone becoming prominent in the sole. In such cases the tendo Achillis is short. The tendon shortness hinders the calcaneum, and with it the astragalus, from being brought to a right angle to the leg—if one attempts to attain such a position the motion is not accomplished at the ankle but between the tarsal bones and is combined with pronation, thus giving rise to flattening of the arch and prominence of the head of the astragalus and navicular bone. In some cases a marked looseness of the tarsal joints develops and the achillotomy plus transplantation of the tibialis anticus are insufficient. Weight on the foot causes it to become pronated to such

an extent that the inner margin of the sole still touches the floor. In such conditions arthrodesis of Chopart's or the talo-tarsal joint ought to precede tendon transplantation. In a few bad cases pronation may be combatted by shortening of the tibialis posticus. Eugen Müller reports many remarkably good results.

According to Vulpius ("Die Sehnenüberpflanzung"), weakness or paralysis of the tibialis anticus and posticus and of the gastrocnemius is the principal cause of paralytic flat-foot (pes abductus pronatus). The appropriate treatment therefore consists, first, in overcorrecting the existing deformity; and, second, in preventing recurrence by strengthening the affected muscles, and if necessary shortening their tendons. The after-treatment includes exercise of the adductors, supinators, and dorsal flexors; and the use of an articulated support to the sole until sufficient muscular strength is developed. One example of Vulpius' method of treatment will suffice:

K. K., four years. Paralysis in second year. Marked equinus and flat-foot. Tib. ant. and post. completely paralyzed. The other muscles in good condition. Shortening of the Achilles and peroneal tendons. *Operation:* Rectification of deformity. Tenotomy of tendo Achillis. Transplantation of peroneus longus on to tibialis posticus, of the extensor hallucis and a good portion of the ext. digitorum on to the tibialis anticus. *Result:* After two months foot was in good position and all movements possible. After one year adduction and supination could be carried out with power.

CHAPTER CVIII

TENDON SHEATHS AND TENORRHAPHY

Operation is most commonly performed on the sheaths of tendons removal of tuberculous disease.

Apply a tourniquet above the site of disease. Make an incision swelling, following the course of the tendon. Split the sheath of the tend open. Retract the edges of the sheath wound with sharp hooks or Dissect away all diseased tissues. If possible, do not touch the wound fingers unless gloves are worn. Rub into the whole wound sterile ic Close the wound by sutures. Apply dressings and splint.

FIG. 1427.

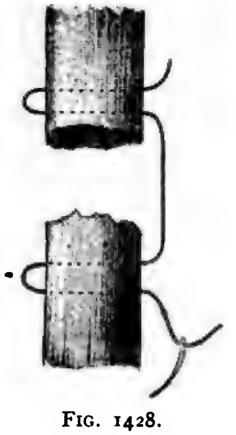


FIG. 1428.

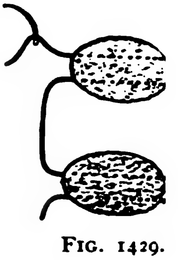


FIG. 1429.

Tendon Suture: Tenorrhaphy.—To avoid unnecessary cutting i to use a round needle, such as is used in intestinal work, but this is not importance. All the ordinary suture materials are used, viz., catgut, sil silkworm-gut, silver wire, kangaroo tendon, etc. If catgut is chosen, it be of the chromicized variety.

The accompanying figures elucidate the various methods of applying better than any number of words (Figs. 1427 to 1436). Note in figure supporting suture, and in figure 1434 the ligatures tied around the en tendon to prevent the sutures tearing out. All the above methods of are applicable where the divided ends of tendon can be brought int apposition. Sometimes it is necessary to suture a round to a flat te which case the flat may be folded over the round and there fixed by a few

(Fig. 1437), or the end of one tendon may be drawn through a split or "button hole" in another tendon and sutured (Figs. 1438, 1439, 1440).

Tendons being composed of parallel bundles of fibres, it is easy for sutures to cut their way out by separating the fibres. Suter ("Arch. f. klin. Chir.," lxxii,

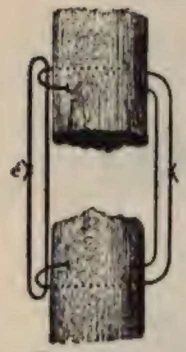


FIG. 1430.

FIG. 1431.

FIG. 1432.

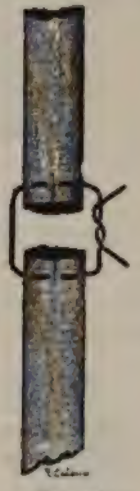


FIG. 1433.

728) describes several easy and efficient means of avoiding this accident. Figures 1441, 1442, 1443, 1444, and 1445, show how the sutures are introduced; the ends of the sutures are tied together at one side of the tendon (Fig. 1446).

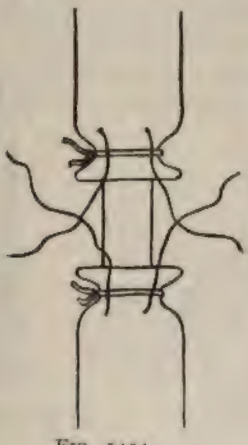
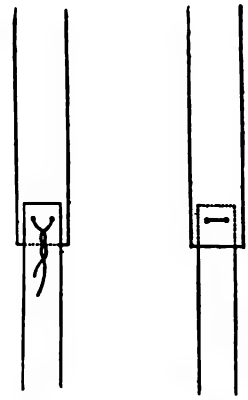


FIG. 1434.

FIG. 1435.

After the sutures are in place tie the two ends A A^1 to the two ends B B^1 (Fig. 1447); and thus obtain lateral approximation of the ends of the tendon. For further security the two ends of suture A A^1 may be made to surround both segments of tendon, and the same may be done with the suture B B^1 (Fig. 1448).

After healing takes place it becomes impossible to distinguish between a union obtained by this method and that by end-to-end approximation. If end-to-end approximation is desired, the sutures A A[1], B B[1], may be used as relaxation sutures. Often it is impossible to bring the ends into the desired apposition, owing to shrinkage, loss of substance, or the exigencies of transplantation, and various



A B
FIG. 1436.

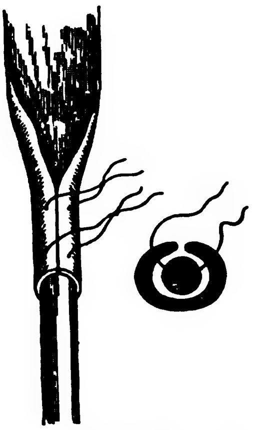


FIG. 1437.

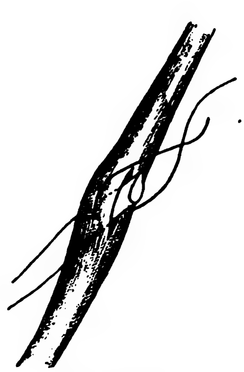


FIG. 1438.

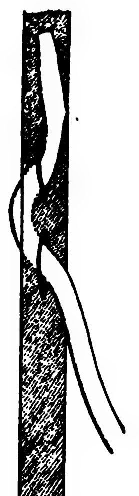


FIG. 1439.

FIG. 1440.

means of tendon lengthening must be used. Figures 1450, 1451, 1452 and 1453 show the best-known methods. Occasionally the above means are inapplicable, and in order to obtain union between the separated ends of tendon it is necessary to fill the gap with some suture material or a graft. Figures 1430 and 1431 show how such sutures may be applied.

Hunkin devised the following useful stitch:

Put the two fore ends of a double silk or hemp suture through the eye of a needle. Introduce the needle into the cut surface of one tendon (X) and make

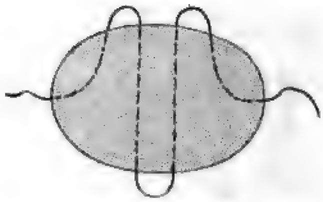


FIG. 1441.

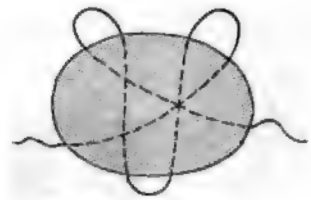


FIG. 1442.

it follow the course shown in Fig. 1454. When the needle at last emerges (Y) tie the ends of the suture Y to the loop X by means of a half-inch.

A number of strands of catgut or catgut and silk together may be formed into a small cable the ends of which may be sutured to the divided end of the tendon.

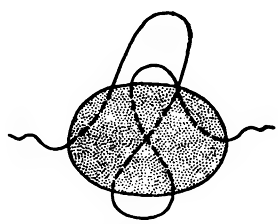


FIG. 1443.

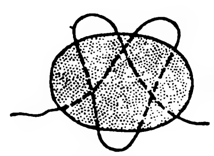


FIG. 1444.

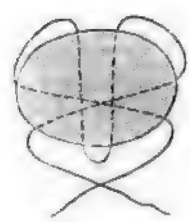


FIG. 1445.

Whatever material is used to fill the gap, it merely acts as a guide or scaffold along which nature may deposit new tendon tissue or a substitute therefor. Vulpius finds that even after aseptic healing silk sutures are ultimately thrown off, without ill result, in 15 to 20 per cent. of all cases when used as ordinary tendon su-

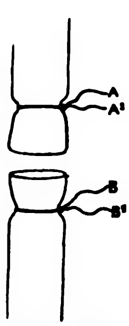


FIG. 1446.

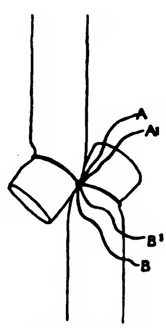


FIG. 1447.

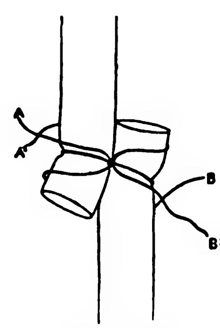


FIG. 1448.

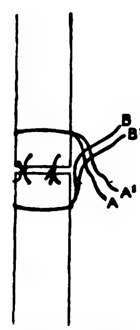


FIG. 1449.

tures. When used as grafts, more damage must follow. Probably as a graft, chromicized catgut or prepared tendon is preferable to silk. A combination of silk and catgut is well recommended. If two neighboring tendons are in part

destroyed by the same accident, a portion of the less important one may be used to replace the defect in the more important (Fig. 1455). When, as a result of an incised wound, *e.g.*, of the dorsum of the foot, a tendon is divided, the proximal end is immediately retracted into its sheath. To find the retracted portion pass forceps up the sheath, seize the tendon, and pull it down. Very commonly,

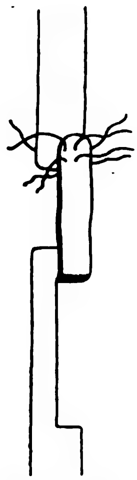


FIG. 1450.

FIG. 1451.

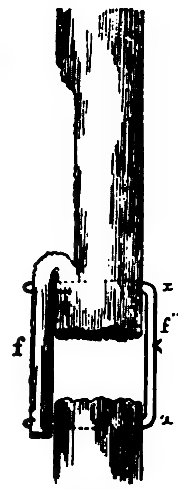


FIG. 1452.

FIG. 1453.

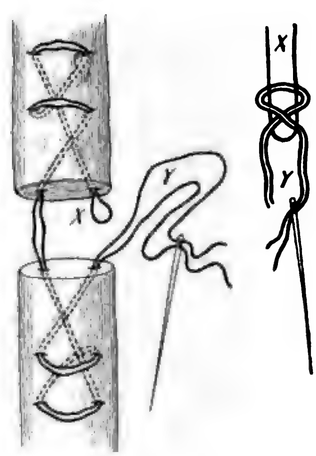


FIG. 1454.

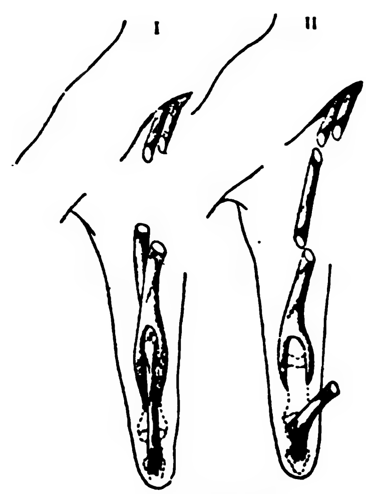


FIG. 1455.

this procedure is futile, and we are compelled to split open the sheath for a greater or less distance upwards. The retracted tendon may be forced downwards by methodically pressing the muscular belly downwards or by applying an elastic bandage tightly around the limb from the origin of the muscle at fault downwards. If after thorough and extensive search the upper end of the tendon

cannot be found, the distal end ought to be united to a neighboring tendon by the methods shown in figures 1438, 1439, and 1440. The approximated surfaces of tendon must, of course, be suitably freshened before the sutures are applied.

Sometimes the proximal end of the tendon is accessible and the distal lost or destroyed. Several methods of treatment are applicable: (*a*) The end of the tendon may be united to the side of a neighboring tendon. (See "Transplantation of Tendons.") (*b*) The end of the tendon may be fixed to the peri-

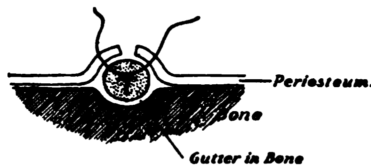


FIG. 1456.

osteum or to the bone itself at a point as near as possible to its normal insertion. (*c*) The end of the tendon may be united to the bone at its normal point of insertion by the intermediation of a catgut or silk graft.

Implantation of tendon to periosteum or bone may be affected as follows:

Method 1 (Lange).—With knife and periosteal elevator raise a flap of periosteum, ½ to ¾ inch in length, at the site chosen for the tendon insertion. Suture the end of the tendon to the periosteal flap. When the tendon is not

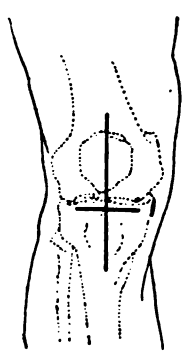


FIG. 1457.

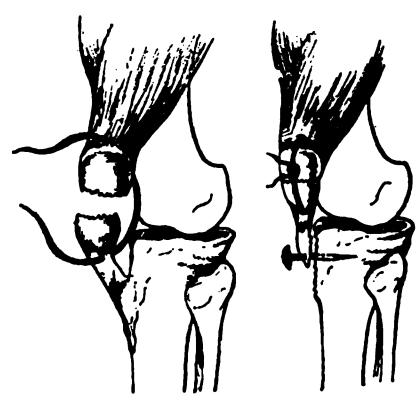


FIG. 1458.

long enough to reach the point of insertion, Lange makes use of a double suture of strong silk as a graft.

Method 2 (Wolff).—Divide the periosteum at the site selected. Reflect the periosteum laterally. With a chisel, cut a gutter or groove in the exposed bone. Place the tendon in the bone gutter. Replace the periosteal flaps *over* the implanted tendon and suture them together and to the tendon (Fig. 1456).

When tendon suturing is done as a secondary operation, the ends of the tendon will be found adherent to a mass of scar tissue lying between them, and

which is firmly adherent to surrounding structures, especially to the skin. Before the vivified ends of the tendon are united, this mass of firm, hard tissue must be thoroughly excised, and adhesions which prevent approximation and gliding of the tendons must be broken down.

Where it seemed impossible to obtain a satisfactory result by excising the scar tissue in a case in which the distal portion of the flexor of the index finger was adherent to the cicatrix, Chassaignac sought for, found, and united the proximal portion of the tendon to the scar close to the distal portion (tendo-cutaneous suture).

After-treatment.—The wound having been closed, if possible without drainage, abundant dressings are applied, and the parts fixed by splints or plaster of Paris in such a position that tension on the sutures is relaxed. No attempts at motion should be made before the lapse of two weeks, in the case of the smaller

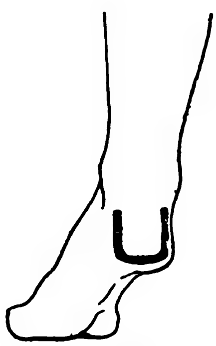


FIG. 1459.

FIG. 1460.

tendons; for the larger tendons, or in cases where grafts (of catgut, silk, etc.) have been employed, a longer period of rest is proper. After this passive and then active motion must be begun, aided by massage and electrical stimulation. Owing to the occurrence of atrophy from disuse the after-treatment will be more prolonged where the tenorrhaphy was secondary than where it was performed at the time of the original injury.

Approximation of Severed Ends of Tendon by Means of Transplanting its Osseous Insertion (Bergmann, Poncet).—It may be impossible, by ordinary means, to approximate the fragments in transverse fracture of the patella in rupture of the ligamentum patellæ or quadriceps tendon, but the following operation may suffice to permit it:

Step 1.—Expose the parts by means of a vertical or crucial incision (Figs. 1457, 1458).

Step 2.—With a chisel separate the tibial tubercle, and with it the ligamentum patella, from the tibia.

Step 3.—Divide any adhesions which prevent approximation.

Step 4.—Unite the fragments of bone or tendon by strong sutures.

Step 5.—The fragments of bone or tendon having been united, the separated tibial tuberosity attached to the ligamentum patellæ has slipped upwards and assumed a new position on the surface of the tibia. Fix the tibial tuberosity in its new position by means of a buried ivory peg or by a steel nail, which is left protruding through the skin wound, to be removed after union has been secured.

Step 6.—Suture the fascia and skin-wounds. Apply dressings. Immobilize with splints or plaster of Paris in extended position and elevate the limb.

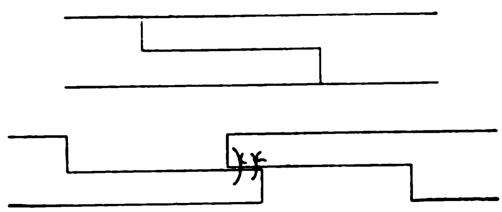


FIG. 1461.

A similar operation may be used in cases where there is much loss of substance in the tendo Achillis or in the tendon of the triceps brachialis. Figures 1459 and 1460 are self-explanatory.

For the correction of deformity, tendons which have never been divided often require to be lengthened. Tenotomy is the most common means of securing the necessary elongation. (See "Tenotomy.") Poncet's method of making shallow lateral incisions (Fig. 1453) may be of service under such

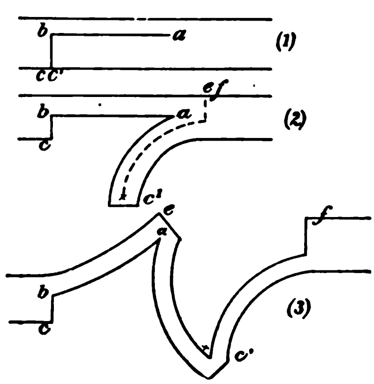


FIG. 1462.

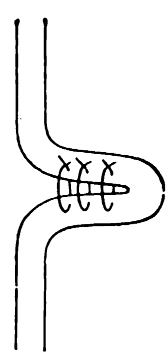


FIG. 1463.

circumstances. Anderson's method of tendon lengthening by splitting, sliding, and suturing is shown in figure 1461. The Hibbs-Sporon method can be readily grasped by glancing at figure 1462.

Tendon Shortening.—After the correction of deformity certain tendons may be too long for the proper transmission of power, or the exigencies of transplantation may require that they be shortened. Figures 1463 and 1464 show a simple reduplication of the tendon. In figure 1465 the tendon is split

longitudinally and the longitudinal converted into a transverse wound. In figure 1466 the whole thickness of the tendon has been cut away with the exception of a thin slip at the side, which aids in the subsequent healing. In figure 1467 a "draw" stitch when pulled tight throws the tendon into folds

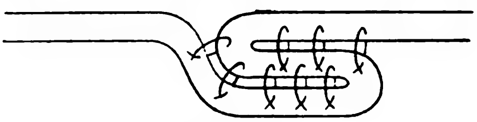


FIG. 1464.

and so shortens it. Figures 1400, 1401, 1402, 1403, show in detail how much a tendon as the Achilles may be shortened. Other methods of tendon shortening will be incidentally described in the paragraphs devoted to transplantation.

Displacement of Peroneus Longus Tendon.—Make an incision about 2 inches in length, obliquely from above downwards and forwards, over the

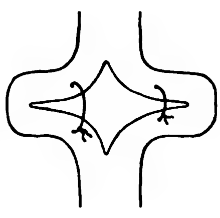


FIG. 1465.

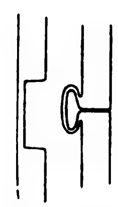


FIG. 1466.

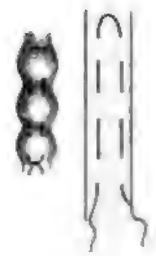


FIG. 1467.

outer surface of the external malleolus (Fig. 1468). Do not cut deeper than the subcutaneous tissue. Expose the external annular ligament, which is torn when the peroneus tendon is luxated. If the fragments of the ligament can be brought into apposition over the tendon, suture them in their normal position. If this cannot be done, expose a larger surface of the external

FIG. 1468.

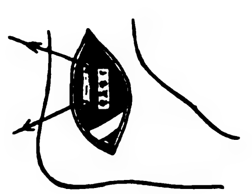


FIG. 1469.

FIGS. 1468 AND 1469.—Operations for displaced peroneus longus tendon.

malleolus and from it raise a flap of periosteum with its base downwards. Turn this flap downwards and suture its free extremity to the remnants of the annular ligament or to the periosteum of the os calcis. Another method consists in making the periosteal flap at a slightly higher level—turning it back over the peroneal tendons and there suturing it to the deep fascia (Fig.

1469) (Walsham). Close the skin-wound without drainage. Dress. Immobilize for two weeks and then begin passive motion.

Instead of using the periosteum, Lexer obtains a free (unattached) slip of tendon from the tendo Achillis or the rectus femoris (of the patient himself or from a recently amputated limb) and either sutures it to the periosteum as a bridge over the peroneal tendon or he nails its ends into a gutter cut in the malleolus above and another gutter cut in the os calcis.

TENDON TRANSFERENCE OR TRANSPLANTATION

Objects.—The objects of tendon transference are:

"(*a*) To fortify a weakened group of muscles.

"(*b*) To supplant a completely paralyzed muscle or group of muscles.

"(*c*) To obstruct, balance or oppose an overacting spastic group.

"(*d*) To deviate tendon action when perverted—as in transference of the tendo Achillis to the outer side of the os calcis in congenital club-foot to prevent inversion of the ankle.

"(*e*) As a help in partial arthrodesis" (Jones).

Principles.—H. O. Thomas has pointed out that a muscle may fail to act and may simulate paralysis because it has been overstretched while weak. This is well seen in wrist drop. Here the weakened extensors may have recovered from the original disease, but the stronger flexors have so stretched and dominated them that they no longer act, while the dominant flexors have assumed a condition of contracture from long-continued want of opposition. If such a hand is gradually brought into a position of overextension and kept in that position for many months *continuously*, recovery may be expected. The recovery is due to shortening of the weakened tendons (the muscles of which ought of course to be treated by massage, etc.) and to elongation of the contracted (flexor) tendons (Tubby and Jones).

This recognition of simulated paralysis is of very great importance when one is deciding on operation. Frequently brilliant immediate results have been obtained by tendon transference, but later there has been relapse. This is commonly due to neglect of the Thomas principle referred to in the preceding paragraph. After being transferred or transplanted, a tendon is naturally weak and the point where it is united to its new insertion consists of weak scar tissue. If after the wound has healed we permit undue strain (exerted by gravity or by opposing muscles) to be inflicted on the transferred tendon it cannot avoid being stretched and becoming useless. The transferred tendon ought to be treated on the same principles as recommended in wrist drop, and the treatment should be kept up until "the patient is able by a voluntary effort to make it forcibly act and it can successfully withstand the action of gravity" (Jones). Some of the methods of carrying out these principles will be discussed later.

Tendon Transplantation.—When there is a loss [illegible]lar function, incapable of spontaneous recovery or of relief by simp[illegible]ndon trans-

plantation may be used. Loss of muscular function may be due to paralysis or paresis of a single muscle or of a group of muscles, or to an excess of power in one muscle or group of muscles, *i.e.*, there is a loss of balance between the muscles acting on a joint. Balance may be restored by transplanting power from the strong to the weak. In order that transplantation may be of use it is essential that the loss of function is limited in extent and that sufficiently powerful muscles are within convenient distance of the weakened ones, *e.g.*, no benefit could accrue from tendon transplantation in the case of a so-called "flail-joint;" the loss of function is too wide-spread and there are probably no neighboring muscles in proper position to lend power. Where there has been loss of tendon from accident or disease, and union, whether direct, by implantation, or by tendon lengthening, is impossible, then transplantation may restore function. Frequently paralysis following acute poliomyelitis is circumscribed, so that healthy muscles are found alongside paralyzed ones; in such cases transplantation may be valuable. Before operating, however, we must be very sure that spontaneous recovery is impossible. Never operate until six or nine months have elapsed since the paralysis appeared. Transplantation is of use not only in restoring function, but in obviating deformity.

The most common forms of partial paralysis requiring operation are those about the ankle evidenced by the presence of talipes calcaneus, paralytic varus and equino-varus, and flat-foot. In spastic paralysis the want of muscular balance may be due to increased power in one set of muscles, with or without diminished power in the opposing muscles. Inflammatory arthritis may cause contractures remediable by transplantation.

A well-defined plan of procedure must be worked out in each case before operation is begun. We must know exactly which muscles are paralyzed completely or partially, and what power is available to aid them. In the case of adults we study the possible voluntary movements. Movements in weakened parts may often be demonstrated only when the corresponding muscles in the opposite limb are set in motion. Children we watch at play and stimulate certain muscles to act by tickling, etc. When contractures are present, they may hinder certain motions and may have caused atrophy in certain muscles from disuse. Electrical tests, according to Vulpius, are of comparatively little value. Weak currents do not stimulate sufficiently; stronger ones excite neighboring or even antagonistic muscles. The application of the electricity frightens children and does not help in distinguishing between paralysis and the atrophy from disuse.

When deformity exists, it ought to be corrected before the required tendon transplantation is attempted, *e.g.*, in paralytic club-foot with paralysis of the extensor digitorum; if we transplant part of the tibialis anticus tendon on to the tendon of the paralyzed muscle and *then* correct the deformity, the tendon is made loose and cannot transmit power to the foot. If, however, we first correct the deformity and *then* make the transplantation, the tendon will have the proper tension for the transmission of power. If the operation for the correction of deformity is severe, transplantation should not be atempted

until the parts have completely recovered from the operative trauma. If contracted tendons hinder complete correction of deformity, Vulpius defers the necessary tenotomy until he is ready to transplant, when he combines tenotomy and tendon splitting.

Lorenz ("Centralblatt für Chir.," 1905, No. 49) considers that the operation has been overdone, especially in cases of paralytic flexion of the knee. In such cases it is easy to produce hyperextension of the knee (genu recurvatum). For him the biceps, semimembranosus and semitendinosus constitute a "*noli me tangere.*" At most, the gracilis, semitendinosus, sartorius and tensor vaginæ may be used to help the quadriceps, but this amount of help is insufficient.

General Remarks on Method of Operating.—Incisions to expose the tendons should be longitudinal and so placed that they may be slid over all the parts it is necessary to expose. An incision ought *not* to be made directly over a tendon; it should be to one side of it. Flaps and V-shaped incisions lead to extensive skin dissection and favor the formation of adhesions.

If the donating tendon is remote from the receiving tendon, a second incision will be necessary, and the tendon is carried from the one opening to

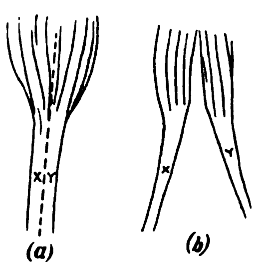


FIG. 1470.

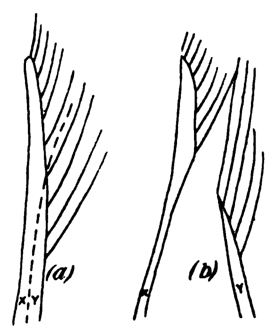


FIG. 1471.

the other through a tunnel bored with a forceps. Numerous incisions may be made into both the donating and the receiving muscle. These incisions let us know the actual condition of the muscles. Next to a dark-red healthy muscle we may find a yellowish-white muscle completely paralyzed and scarcely distinguishable from the surrounding fat. Another muscle may show varying shades of rose color (atrophy from disuse); such a muscle may recover. In still another muscle we may find all three conditions—health, paralysis, atrophy in streaks.

In exposing the donating tendon a very long incision may be required, especially if it seems necessary to form two muscles out of one. Under such circumstances not only is a slip split off the donating tendon, but the tendon split or incision is carried well up into the muscle belly. In continuing the "split" up into the muscle do so by blunt dissection, and see that the portion of muscle left attached to each segment of tendon normally belongs to that

segment. This renders possible the formation of two physiologically distinct muscles out of one (Figs. 1470 and 1471). The donating tendon must be conducted by as straight a route as possible to the receiving one. To succeed in this, *e.g.*, when a flexor of the leg is to donate power to an extensor or *vice versa*, it may be necessary and proper to conduct it through a tunnel bored in the interosseous membrane.

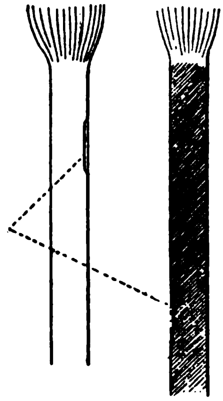


FIG. 1472.

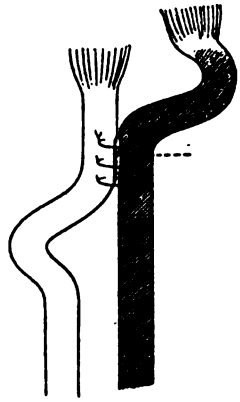


FIG. 1473.

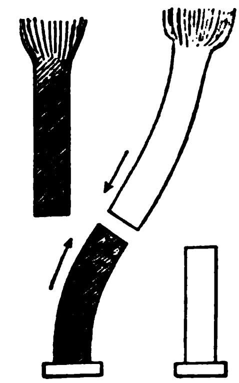


FIG. 1474.

A tendon receives nourishment from its muscle, its bone insertion, and *its sheath*, hence R. Jones, whenever possible, transplants the tendon sheath along with the tendon.

When exposing tendons through a long cutaneous incision it is not necessary to divide the fascia throughout the whole length of the wound; the fascial

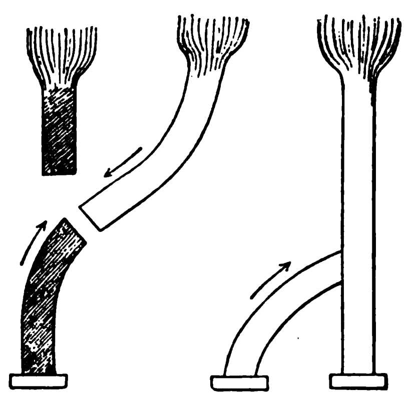


FIG. 1475.

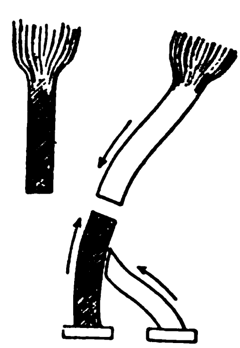


FIG. 1476.

cut may be interrupted in places and thus union is rendered easier and more exact. The fascia should never be divided near its insertion into bone, otherwise union will be difficult.

Methods of Uniting Transplanted Tendons.—Most of what has been written as to the union of divided tendons is applicable here. Figures 1477

to 1484 illustrate sufficiently the usual methods of transplantation. In the figures the non-paralyzed muscle and tendon (the donor) are uniformly left unshaded; the paralyzed muscle and tendon (the receiver) are shaded. Before applying sutures always vivify the surfaces to be united, and always pull up any "slack" there may be in the receiving tendon so that sufficient tendon

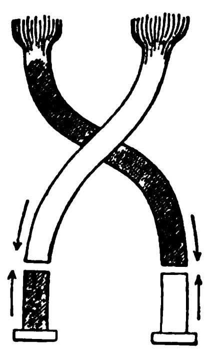


FIG. 1477.

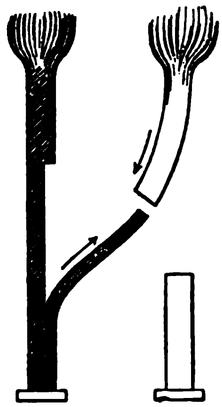


FIG. 1478.

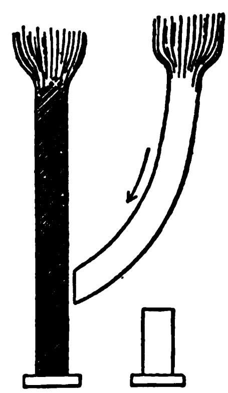


FIG. 1479.

tenseness is secured to permit of transference or application of muscle power to the point of tendon insertion. A lax tendon between muscle and point of insertion is useless.

In Fig. 1474 the tendons both of the donor and of the receiver are completely divided and the peripheral portion of the donor is discarded, *i.e.*, none

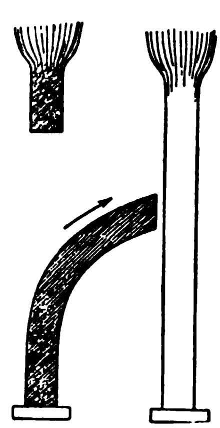


FIG. 1480.

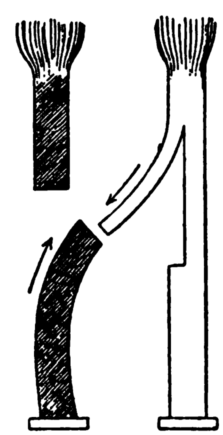


FIG. 1481.

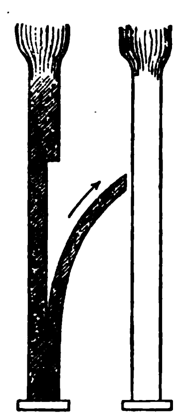


FIG. 1482.

of the normal function of the donor is retained. This procedure is justifiable only when the donor is an entirely unimportant muscle or if, under the circumstances for which operation is undertaken, its normal action is objectionable. Functionally negligible muscles are rare, and unexpected evils are liable to follow

when even unimportant muscles are entirely cut off from their normal insertion. To obviate part of this, many devices have been suggested, and most of them will be easily understood after a glance at the figures.

Robert Jones believes that the union between the two tendons should be as near the insertion of the receiving (paralyzed) tendon as possible to avoid

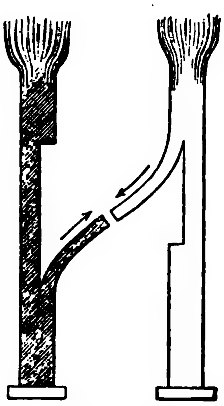


FIG. 1483.

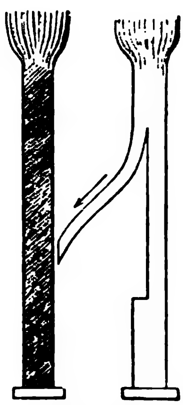


FIG. 1484.

dangers from subsequent stretching of that structure. He prefers, if possible, to implant the end of the "donor" into the periosteum in a suitable place rather than into the tendon of the paralyzed muscle.

Lange in his transplantations makes free use of artificial tendons of silk (see p. 1221).

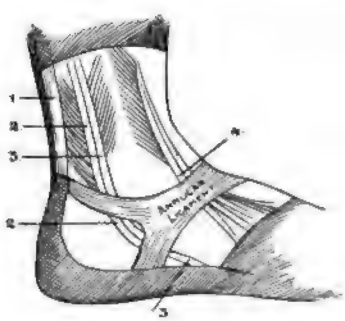


FIG. 1485.

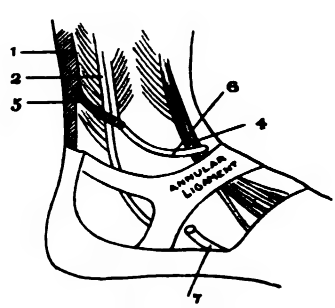


FIG. 1486.

1. Tendo Achillis. 2. Peroneus longus. 3. Peroneus brevis. 4. Extensor tendons. 5. Slip from tendo Achillis. 6. Tendon of peroneus brevis used as a graft.

Indirect tendon transplantation may be necessary when the donor is not long enough and when the ordinary methods of implantation seem inadvisable. Mainzer (quoted by Vulpius) used the following plan in a case of paralysis of the extensors of the toe: From a slip from the tendo Achillis (Figs. 1485 and 1486); suture the end of this slip to an appropriate point on the peroneus

brevis tendon. Divide the tendon of the peroneus brevis at such a place that a sufficiency of the tendon is left below the point of suture with the tendo Achillis to reach from that point to the extensors which require strengthening. Pull this chosen portion of tendon centralwards out of its sheath and sew its end to the extensors (Fig. 1486, 6).

Closure of Wound.—Suture the wounded tendon sheaths with very fine catgut. Carefully suture the deep fascia with buried sutures. Close the skin-wound. Apply abundant dressings and a stiff bandage.

Several methods (apart from splints and apparatus) are available by means of which the transferred tendon may be protected from overstretching until such time as it gains strength. Hoffa exposed the completely paralyzed tendons which were supplanted by the operation and shortened them so that they could act as cords, keeping the limb in a position of overcorrection. Division or lengthening of the active opposing tendons which stretch the transferred tendon is harmless and useful. Robert Jones, in addition to the above methods, makes use of his "skin-flap removal" to secure uninterrupted continuity of the overcorrection.

After-treatment.—Keep immobilized for six weeks in simple cases, for eight weeks in cases where there has been much deformity, especially bony deformity, corrected. The period of rest is shortened if there is cause to fear adhesions, *e.g.*, if the tendon has been left outside the fascia or traverses an interosseous space. For a period of four weeks the patient ought to remain *in bed* to avoid any chance of injury to the lines of suture. After union is complete applications of moist and dry heat stimulate the circulation. Electrical stimulation is advantageous. Passive motion and, as soon as possible, gymnastic exercises are necessary. When the patient begins walking some simple form of supporting apparatus or boot will be necessary for a longer or shorter time.

Examples of Tendon Transplantation.

I. Talipes equinus—due to infantile palsy. The tibialis anticus and the extensor communis digitorum are alone affected. Power from the extensor proprius hallucis and from the peronei muscles may be transferred to the tendon of the paralyzed muscles. In all the operations for equinus it is presumed that any shortening of the tendo Achillis which obstructs overcorrection has been overcome by tenotomy or by tendon lengthening.

(A) Transplantation of a "slip" from the tendon of the peroneus brevis to the extensor digitorum.

Step 1.—From a point at least five fingers' breadth above the intermalleolar space make a median incision downwards. Curve the lower end of the cut slightly inwards. Divide the skin alone. In the subcutaneous tissue of the lower part of the wound lie the terminal filaments of the musculo-cutaneous nerve. Preserve these if possible.

Step 2.—Split the deep fascia throughout the whole length of the wound close to the tendons of the extensor digitorum and peroneus brevis which can

be seen through the fascia. Separate the extensor digitorum from its surroundings for a short distance (Fig. 1487).

Step 3.—From a point slightly below the external malleolus make an incision upwards parallel to and about ½ inch behind the fibula for a distance of 5 inches. Incise the sheath of the peronei. Isolate the tendon of the peroneus brevis. Split this tendon, carrying the split as high up as possible, in such a manner as to divide it into an anterior and posterior segment. Divide the anterior segment at the level of the malleolus. This forms a flap of tendon having its base above.

FIG. 1487.

FIG. 1488.

FIGS. 1487 AND 1488.—Tendon transplantation. (*Berger and Banzet.*)

Step 4.—With forceps and knife make a tunnel from the wound made in Steps 1 and 2. This tunnel must hug the outer side of the fibula, which is bared for a distance of about 2 to 3 inches. Pull the flap of peroneus brevis tendon through this tunnel so that it now lies in the front of the leg.

Step 5.—Hold the foot in a position of exaggerted doral flexion. Pull the extensor communis tendon upwards until it is tense and then make a longitudinal button-hole in it. Through the button-hole pull the flap of the brevis from behind forwards and suture as great a surface as possible of one to the other (Fig. 1487).

Step 6.—Close all the wound after painstaking hemostasis; dorsal flexion.*

(B) Transplantation of a Slip from the Extensor Proprius Hallucis to the Tibialis Anticus.

This operation may be performed either as an independent procedure or to supplement the flexing power given by the peroneus brevis to the extensor digitorum as described in the previous paragraphs. Steps 1 and 2 as in the preceding operation.

Step 3.—Retract the edge of the wound inwards. Expose the extensor proprius hallucis and its tendon. Split the tendon into an outer and an inner segment. Divide the outer segment transversely at the level of the annular

FIG. 1489

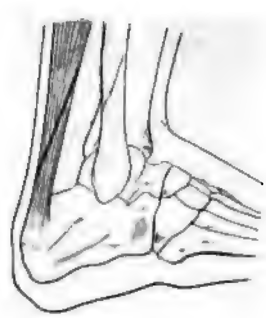


FIG. 1490.

FIGS. 1489 AND 1490.—Tendon shortening. (*Labey.*)

ligament, so as to provide a tendon flap united to the muscle above and free below.

Step 4.—Isolate the tendon of the tibialis anticus and pull it upwards, flexing the foot dorsally. Make a longitudinal button-hole in the tendon. Pull the free end of the tendon flap (from the ext. proprius hallucis) through the button-hole and unite it there as in Fig. 1488.

II. Talipes Equinus Due to Infantile Palsy.

The tibialis anticus and extensor communis digitorum are paralyzed. The peroneus brevis is not available as a donor of power. The extensor proprius hallucis is healthy.

Transplantation of a Slip from the Ext. Proprius Hallucis to the Extensor Communis Digitorum. Shortening of the Tibialis Anticus.

Step 1.—From a point at least five fingers' breadth above the intermalleolar space make a median incision downwards. Curve the lower end of the cut

* This description and some others closely follow Berger and Banzet.

slightly upwards. Divide the skin alone. Preserve, if possible, the terminal filaments of the musculo-cutaneous nerve in the subcutaneous tissue.

Step 2.—Split the deep fascia. To the inner side of the tendon of the ext. communis, recognize and isolate the tendon of the ext. proprius hallucis.

Step 3.—Split longitudinally the tendon of the ext. proprius into an outer and inner segment. Divide the outer segment transversely at the level of the annular ligament (Fig. 1488).

Step 4.—Pull the ext. com. digitorum upwards, strongly flexing the foot. Make a longitudinal button-hole in this tendon and pull through the button-hole the mobilized flap provided at the expense of the ext. proprius. Suture securely.

FIG. 1491.

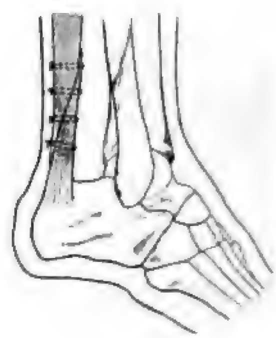


FIG. 1492.

FIG. 1491 AND 1492.—Tendon shortening. (*Labey.*)

Step 5.—Retract the inner edge of the wound and expose the tendon of the tibialis anticus and shorten it in the same manner as the tendo Achillis is depicted as being shortened in Figs. 1489, 1490, 1491, 1492.

After any of the operations such as have been now described, Robert Jones endeavors to keep the united tendons free from tension by means of the removal of skin flaps. He writes: "Personally I see that the deformity of the foot is overcorrected before any operation is performed; and as soon as the tendon is transplanted, as in arthrodesis, I remove an oval skin flap from the paralyzed side so large that when the edges are sewn together the foot remains fixed in an overcorrected position. The removal of the skin flap, I venture to suggest, gives us considerable help in removing strain from the transplanted tendon. The foot by this means, as I have before said, remains in the desired position in spite of any outside influences." The reader will easily see how Jones's method may be applied to the operation here described and how valuable it is calculated to prove.

Regarding tendon transplantation in paralytic club-foot, Royal Whitman writes: "Tendon transplantation is most effective from the curative standpoint when but one muscle of the anterior leg group, for example an adductor or abductor, is paralyzed. The most common form of this milder type is paralysis of the tibialis anticus. As this muscle is the most powerful dorsal flexor and adductor of the foot its loss is followed by secondary equino-valgus. In Parish's operation the tendon of the adjoining extensor proprius pollicis was simply attached to that of the tibialis anticus, but as the extensor of the great toe is a very weak muscle, its power is hardly sufficient for the double task. A more efficient procedure is to split the tendon of the paralyzed muscle. The outer half is then separated from its muscular attachment, and the distal extremity is carried across the foot and is sutured to all the other tendons. The proprius pollicis is then attached to the inner half. In cases of longer standing and more marked deformity it is well to reduce the power of the abductors by cutting the tendon of the peroneus tertius from its insertion. This is then drawn beneath the other tendons and is attached to that of the tibialis anticus. All of the tendons on the front of the ankle may then be sutured to one another, so that all may act as direct dorsal flexors."

"The relative strength of the muscles, as well as their function, should be considered in selecting grafts, and in prognosis also. According to Fick, it is as follows, in kilogrammeters:

Back of the Leg

The calf muscle—gastrocnemius and soleus	8.21
Tibilalis posticus	0.40
Peroneus longus	0.44
Flexor com. digitorum	0.37
Flexor longus pollicis	0.82
	10.24

Front of the Leg

Tibialis anticus	1.61
Extensor proprius pollicis	0.39
Extensor longus digitorum	0.72
Peroneus brevis	0.31
Peroneus tertius	0.20
	3.23

"The importance of the calf muscle on the back, and tibialis anticus on the front of the leg, is apparent. The former is nearly four times as strong as the combined posterior group, the latter equal to all the others on the front of the leg. It has been claimed that the transplanted muscle may become hypertrophied, and that its strength may increase sufficiently to carry out its new function, but this is somewhat doubtful."

III. The muscles of the calf are paralyzed. Talipes calcaneus has resulted. If the muscles are not hoplessly paralyzed, an application of Thomas' principles

and prolonged immobilization of the leg with the foot in a position of plantar flexion may lead to regeneration. It is most important to remember this and to avoid immediate recourse to what may be a needless operation.

(A) Shortening of the tendo Achillis has been frequently employed (Willett, Gibney, and others). The methods of tendon shortening are sufficiently described (p. 1223). It is more logical, however, to supply new power to the tendon rather than merely to shorten it until it acts as a sort of passive support to the heel.

(B) **Transference of a Tendon Flap from the Flexor Longus Digitorum to the Tendo Achillis.**

Step 1.—From a point about 1 inch below the tip of the internal malleolus make a 4-inch incision upwards midway between the tendo Achillis and the posterior border of the tibia. Expose the inner border of the tendo Achillis.

FIG. 1403.—Tendon transplantation. (*Berger and Banzet.*)
V. Vessels. FL.FL., Flexor longus. T.A., Tendon Achillis. 1. Intact portion tendon of flexor longus. 3. Flap from tendo Achillis. 2. Flap from long flexor.

Step 2. Split the tendo Achillis in such a fashion as to provide a tendinous flap, 2 1/4 inches long, free above and attached to the os calcis below.

Step 3. Incise the deep fascia parallel and close to the posterior border of the tibia. Avoid injury to the sheath of the tibialis posticus and to the vessels which lie posterior to the flexor digitorum and between it and the flexor proprius hallucis. Expose and isolate the tendon of the flexor longus digitorum opposite the internal malleolus.

Step 4.—Divide the tendon (flex. digit.) longitudinally into an anterior and posterior segment. Leave the anterior segment intact. Divide the posterior segment transversely low down so as to make it into a flap with pedicle above.

Step 5.—Put the ankle in a position of great plantar flexion. Lay the two flaps obtained from the tendo Achillis and the long flexor alongside each other and unite them by sutures (Fig. 1493).

Step 6.—Shorten the intact portion of the tendo Achillis.

Step 7.—Close the wound. Dress. Immobilize in a position of plantar flexion.

(C) **Transference of a Tendon Flap from the Peroneus Longus to the Tendo Achillis.**

Step 1.—From a point about 1 inch below the external malleolus make a 4-inch incision upwards between the fibula and the tendo Achillis.

Step 2.—Expose the outer border of the tendo Achillis and from it fashion a substantial flap—about 2¼ inches long—free above, united to the os calcis below.

FIG. 1494.—Tendon transplantation. (*Berger and Banzet.*)

L.P. Peroneus longus. T.A., Tendon Achillis. C.P., Peroneus brevis. 1. Intact portion tendon peroneus longus. 2. Flap from peroneus longus. 3. Flap from tendo Achillis.

Step 3.—Incise the deep fascia parallel and close to the posterior border of the fibula. Expose and open the sheath of the peronei muscles. The tendon of the p. longus lies posterior to that of the brevis.

Step 4.—Split the tendon into an outer and inner segment. Leave the outer segment intact. Divide the inner segment transversely, low down below the malleolus, so as to form a flap with its pedicle above.

Step 5.—Put the foot in a position of equinus and hold it there. Lay the two flaps of tendon (from the peroneus longus and from the tendo Achillis) alongside each other and unite them with sutures.

Step 6.—Shorten the intact portion of the tendo Achillis.

Step 7.—Close the wound. Dress. Immobilize in a position of equinus (Fig. 1496).

(D) A combination of operations B and C may be employed.

(E) Transference of slips from the tibialis posticus and peroneus longus to the paralyzed tendo Achillus.

Step 1.—Make the forked incision A B C D (Fig. 1495). Reflect the flaps A B C, A B D, C B D. In doing this preserve and retract the external saphenous vein and nerve which lie at the outer side of the tendo Achillis.

FIG. 1495.—Tendon transplantation. (*Labey.*)

Step 2.—Split the fascia so as to expose the outer edge of the tendo Achillis. Freely split open the sheath of the peronei.

Step 3.—Divide the tendon of the peroneus longus into an anterior and posterior segment. The muscle fibres are inserted into the tendon in the pennate fashion, therefore it is easy to continue the cut in the tendon upwards so as to form two muscular bellies each attached to a slip consisting of half of the tendon (Fig. 1496). Carefully avoid injury to any nerves entering the muscle. Transversely divide the posterior slip of tendon as low down as possible.

Step 4.—Make a longitudinal cut into the outer side of the tendo Achillis. Retract the edges of the cut so as to form a gutter (Fig. 1496). Implant the mobilized posterior segment or slip of peroneus tendon into the gutter in the tendo Achillis and fix it there by sutures (Fig. 1497).

Step 5.—Split the fascia on the inner side of the tendo Achillis. Retract the tendon outwards to expose the deep fascia under which can be seen posterior tibial vessels and nerves. Split the deep fascia longitudinally internal to the vessels and nerves; retract these structures. This exposes the tibialis posticus in the depth of the wound (Fig. 1498).

Step 6.—Isolate and split the tendon of the tibialis posticus; imbed one of the segments into the tendo Achillis exactly as was done with the peroneus longus. During all these procedures the foot must be held in a position of overcorrection.

Step 7.—Close the wound. Dress. Immobilize in a position of over correction.

(F) The flexor proprius hallucis may be implanted into the tendo Achillis by an operation almost identical with that for the tibialis posticus, and implantation of the peroneus brevis is almost identical with that of the longus.

IV. The abductors of the foot (extensor communis digitorum, peroneus longus and brevis) are paralyzed. The foot assumes the position of varus.

(A) Transference of power to the peronei by means of a slip of tendon

derived from the tendo Achillis. (The following description closely follows that of Labey, "Chir. du Membre inférieur.)

Place the patient on his sound side in the latero-ventral posture. Flex the leg on the thigh. Have an assistant hold the foot.

Step 1.—From a point ½ inch below the level of the point of the malleolus, cut upwards midway between the posterior border of the external malleolus and the external border tendo Achillis, to the level of the middle of the calf. Expose and retract, uninjured, the external saphenous vein and nerve.

Step 2.—Expose and free the outer border of the tendo Achillis. In the upper part of the wound expose the muscular belly of the outer head of the gastrocnemius, and working from above downwards separate it from the soleus

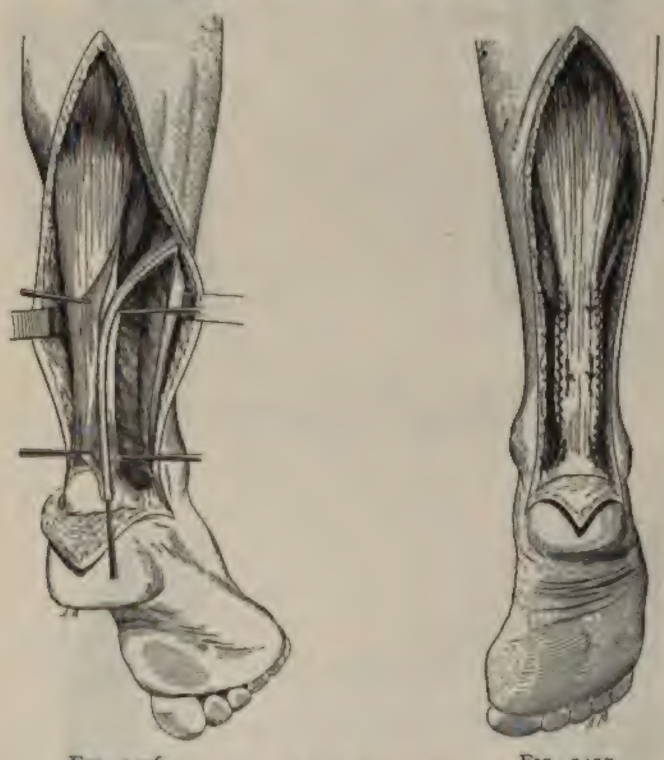


FIG. 1496. FIG. 1497.
FIGS. 1496 AND 1497.—Tendon transplantation. (*Labey.*)

until a point is reached where their fusion is complete and further separation is impossible. Relax the tendon by plantar flexon of foot.

Step 3.—With a knife split the tendo Achillis as in Fig. 1499. The slip of tendon is continuous above with the gastrocnemius, but is free from the soleus. Divide the slip of tendon transversely low down so as to convert it into a flap.

Step 4.—Divide the fascia covering the peronei muscles in the lower three-fourths of the wound. Isolate the peroneus longus (superficial) and the brevis

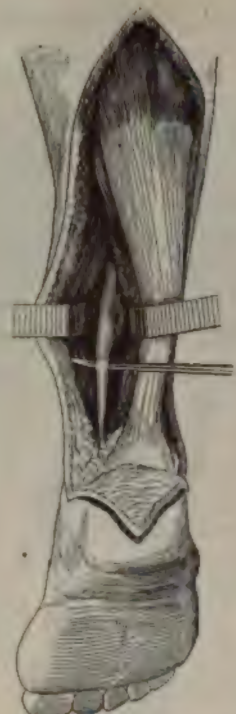


FIG. 1498.

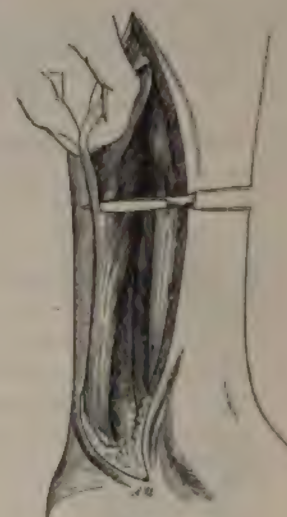


FIG. 1499.

FIGS. 1498 AND 1499.—Tendon transplantation. (*Labey.*)

FIG. 1500.

FIG. 1501.

FIGS. 1500 AND 1501.—Tendon transplantation. (*Labey.*)

(more deeply situated). Retract the tendon of the longus. The muscular fibres of the brevis are inserted into a flat tendon which is superficial to these fibres. Make a longitudinal split penetrating to half the thickness of the muscle and retract the edges of this split so that the peroneus brevis now forms a sort of gutter into which the tendon of the longus is permitted to fall (Fig. 1497).

Step 5.—Pull the mobilized flap of tendon Achillis through between the peroneus longus and brevis (Fig. 1500), and fix it there by sutures as in Fig. 1501. When bringing the tendon flap into position twist it carefully in such a

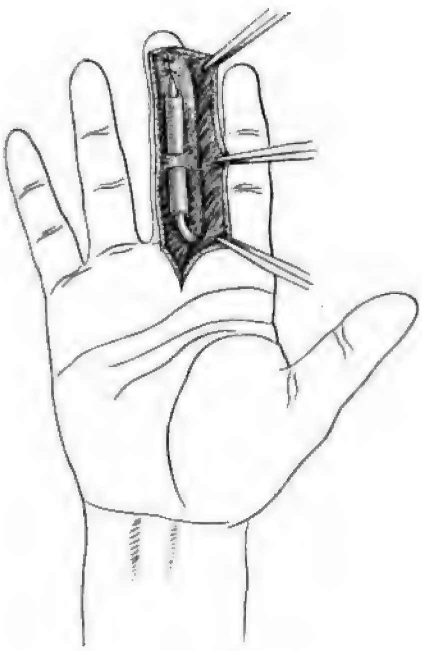


Fig. 1502.

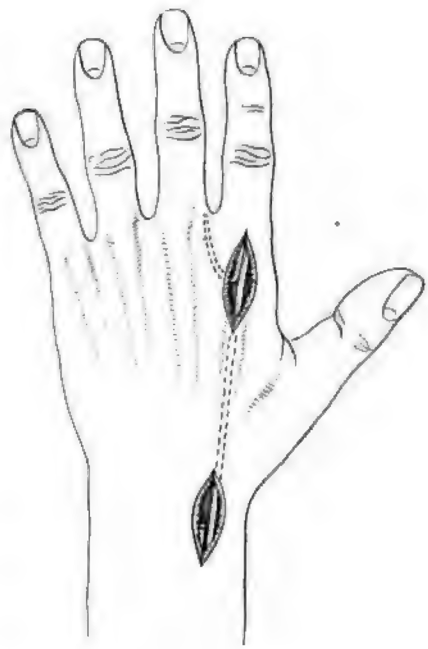


Fig. 1503.

Figs. 1502. and 1503.—Tendon transplantation. (*von Hacker.*)

fashion that its posterior surface (which has *not* been vivified or cut) lies against the cut surface of the soleus so as to avoid the formation of adhesions.

Step 6.—Close the wound. Dress. Immobilize in a posture of plantar flexion and outward rotation.

V. A finger flexor tendon is lost. Repair by transplantation.

v. Hacker ("Beiträge zur klin. Chir.," lxvi, Hft. 2, p. 279. Ref. "Journ. de Chir.," May 10, 1910) reports the case of a young girl who lost the flexor tendons of the middle finger as a result of a deep whitlow. v. Hacker operated as follows: He made a skin flap (Fig. 1502) which exposed the whole palmar aspect of the middle finger and showed the complete absence of the flexor tendons. Next he made two incisions (Fig. 1503) along the line of the extensor communis digitorum over the second metacarpal bone. Through these incisions

he split the tendon, forming a long flap of tendon having its pedicle near the base of the index finger. This flap he passed through a subcutaneous tunnel to the palmar aspect of the middle finger and sutured its end to the periosteum of the ungual phalanx. To avoid peritendinous adhesions he surrounded the transplanted tendon with a piece of freshly removed hernial sac and in the middle of the finger sutured across the tendon a band of fibrous tissue obtained from the débris of the tendon sheath destroyed by the whitlow. The wounds were sutured and healing took place by first intention. Sixteen days later the stump of the old flexor tendon was exposed in the palm and sutured to the proximal end of the transplanted flap of tendon, which was of course, divided from its old connections on the dorsum of the hand. Closure of the wound and immobilization in a position of flexion was followed by healing. Eighteen months later the patient could close her fist completely.

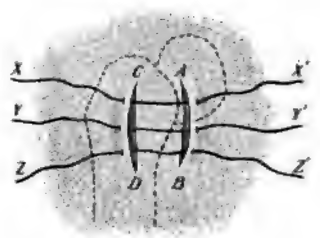


FIG. 1504.—Davis' operation.

VI. There is paralytic eversion of the leg necessitating the use of apparatus which must be fastened to a pelvic band. To obviate the necessity of apparatus G. G. Davis proceeds as follows:

(*a*) The Tensor Fasciæ Femoris muscle is *not* paralyzed. Make a vertical incision about 2½ inches in length down to the great trochanter near its anterior edge. From this cut elevate the periosteum backwards for a short distance. Undermine the skin anteriorly to the wound and expose the tensor fasciæ femoris at its insertion between the layers of the fascia lata. Make a flap of the muscle with its pedicle above. Unite the free end of the muscle flap to the posterior (elevated) edge of the periosteal wound.

(*b*) The tensor fasciæ femoris is paralyzed. Expose the trochanter major as already described. Undermine the skin forwards from the original incision, exposing the fascia lata. At an appropriate distance in front of the trochanter major incise (A B, Fig. 1504) the fascia parallel to the incision in the periosteum (C D), unite the posterior edge of the periosteal wound C D to the anterior edge of the fascial wound A B by the sutures xx'-yy'-zz'.

CHAPTER CIX

TENOTOMY

There are two methods of performing tenotomy: (A) The open operation; (B) the subcutaneous operation.

(A) **Open Operation.**—Make an incision of sufficient length to expose the parts to be divided. Usually this cut is made parallel to the tendon. Isolate, by blunt and sharp dissection, the segment to be divided. Retract surrounding structures. Sever the tendon. Close the wound. If it is impossible or improper to isolate the offending structure, expose it by retracting

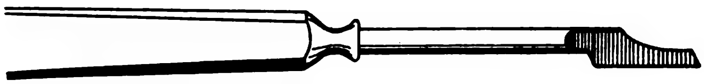


FIG. 1505.—Jones's tenotome.

the edges of the superficial wound, and then make the section, cautiously and with small cuts, under guidance of the eye.

(B) **Subcutaneous Operation.**—For this operation small, narrow-bladed knives (tenotomes) are necessary. Usually a sharp-pointed straight tenotome suffices, but a probe-pointed instrument is occasionally useful. The shorter and narrower the blade, the better it is, so long as it is sufficiently strong (Figs. 1505, 1506). The advantages of subcutaneous tenotomy are (*a*) diminished danger of infection; (*b*) absence of scar. The dangers of injury to neighboring important structures are slight, and in most localities easily avoided.

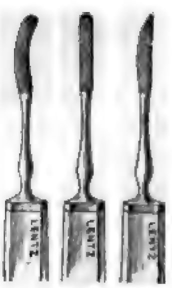


FIG. 1506. Tenotomes.

Tenotomy of Tendo Achillis (Achillo-tenotomy).—1. Cleanse the foot and leg, and turn them over on to the outer side. By palpation locate the most accessible part of the tendon. (The position of choice for section is ½ inch above the insertion in infants and 1½ inches in adults.)

2. Introduce a sharp-pointed tenotome through the skin under, *i.e.*, anterior to, the tendon. Keep the flat surface of the tenotome parallel to the tendon.

3. Turn the cutting-edge of the tenotome against the tendon.

4. Have the assistant flex the foot until the tendon is tense.

5. Press the tenotome against the tendon and by a slight levering motion divide it. Take care not to injure the skin.

6. Withdraw the knife after turning its blade once more parallel to the tendon. Apply dressings.

N. B.—Beginners frequently perforate the tendon with the tenotome and do not get complete division. Many surgeons in Step 2 pass the tenotome behind the tendon and cut forward; others, having made a passage along-side the tendon with the sharp-pointed tenotome, substitute a probe-pointed one of the division of the tendon.

Tenotomy of Tibialis Anticus.—This tendon is usually divided near its insertion into the internal cuneiform. The surgeon stands on the opposite side of the leg to that of the tendon. The assistant grasps the leg and the foot in his hands. Abduction and plantar flexion demonstrate the position of the tendon.

Step 1.—Place tips of fingers on the opposite edge of tendon.

Step 2.—Introduce the tenotome through the skin a short distance from the proximal edge of the tendon.

Step 3.—Change the direction of the knife and pass it horizontally over the tendon until its point is felt by the finger guarding the opposite side.

Step 4.—Have the assistant make the tendon tense (abduction and plantar flexion of foot).

Step 5.—Turn the edge of tenotome against the tendon and divide it.

Step 6.—Withdraw tenotome. Dress in a position of eversion.

Tenotomy of Tibialis Posticus.—Point of division should be about $1\frac{1}{2}$ inches above the internal malleolus. The surgeon stands in same position as in tenotomy of the tibialis anticus. Demonstrate the tendon by abduction and plantar flexion of the foot.

Jacobson writes: "In fat infants it is often quite impossible to feel the tendon, and in these cases a spot midway between the anterior and internal borders of the leg will be the best guide, as denoting the inner margin of the tibia. The surgeon then introduces a sharp tenotome so as just to touch, if possible, the inner margin of the tibia, taking care to sink the blade sufficiently to open the sheath freely. This being done, a blunt tenotome is introduced through the same opening, and pushed under the tendon; the edge being then turned towards it, and the tibia used as a fulcrum, the tendon is severed, together with that of the flexor longus digitorum."

Division of Plantar Fascia.—The plantar fascia may be divided in several places: immediately in front of its origin from the os calcis; beside the transverse crease which is present in all marked cases of plantar contracture, or in any line which may seem suitable. Division in more than one place may be necessary before satisfactory results are obtained.

Step 1.—The assistant makes the fascia tense, and the surgeon, by palpation, satisfies himself as to its "geography."

Step 2.—A tenotome is introduced through the skin, at the inner side of the fascia (the fascia is not kept tense at this stage), and passed, with its flat surface parallel to the skin, between the skin and fascia across the sole until its point is beyond the outer edge of the fascia.

Step 3.—The cutting-edge of the tenotome is turned against the fascia, now made tense by the assistant, and this structure is divided.

Step 4.—The tenotome is withdrawn, suitable dressings applied, and the foot immobilized in a position of overcorrection.

Little's disease; spastic paraplegia. A large proportion of children suffering from severe paralysis may be transformed into useful beings and enabled to walk with comparatively little deformity. Robert Jones writes regarding tenotomy of spastic muscle, "Empiricism has taught us that for some reason or another tenotomy lessens, both in frequency and intensity, the spasmodic element in paraplegia. I do not merely mean to say that division of the tendo Achillis controls spasm in the calf muscles, although of course it does, but rather that spasm in which those muscles are not directly concerned is also influenced." * * * "The practical deduction from these observations is, that no opportunity should be lost of performing a tenotomy. Even in mild cases, where a spastic tendon is to be felt, we need have no hesitation in dividing it.

"If the surgeon has decided that a case of spastic paralysis is suitable for treatment, a splint should be prepared so designed as to keep the limbs in pronounced abduction. The area over the hamstrings, the adductors at the groin, and the tendo Achillis should be suitably prepared for operation. The adductors should be first attacked. An incision an inch or two long should be made to the inside of the adductor longus. This muscle should be seized by a forceps and about ¾ inch of it removed. The limb is then abducted and portions of the adductor brevis and gracilis are exsected in similar fashion. The horizontal portion of the adductor magnus, and, if necessary, the pectineus, is divided, and also any tissue, muscular or fibrous, obstructive to an absolutely free abduction of the femur. Experience has shown me that although the chief offenders are the adductors longus and brevis, nevertheless the deeper muscles often require division. To anyone who has practised the operation, the futility of attempts to divide the muscles effectively subcutaneously, will be apparent. Division is followed with but little hemorrhage and the wounds are closed without drainage. Having exsected the pieces of the adductors each tendo Achillis is divided, or, better still, elongated, for we often note that after division of the tendon outright, there is a tendency to walk too much on the heel. Rectangular splints are then applied to the foot. The limbs are then well abducted and the surgeon notes whether there is any obstacle to easy extension of the knees. If there should be (it is not often the case), an open incision must be made on each side of the popliteal space and the tense hamstrings are in turn divided. If these incisions are long enough the fascial contraction can be attacked on either side, for it is here that opposition is found. I would discourage the use of a transverse incision, as when adopted it often seriously hampers the surgeon's efforts to fully extend the knee by reason of the strain cast upon the sutures. Simple division, however, with fasciotomy, usually suffices to allow of easy extension, and excision of tendons could do no more. In 1885, when I was at the Stanley Hospital, there used to be an adult diplegic always at the gates in a perambulator, and on two or three occasions I took him in to try and straighten his contracted limbs. On one occasion I removed about an inch from each of the hamstrings, but he was mentally so deranged that we did not do each other any credit. I mention the fact, however, because Lorenz of Vienna has quite recently written on the advantage of exsecting portions of the hamstrings.

"We have now presumably got our patient stretched comfortably upon an abduction frame, and we must keep him there for three months. The wounds heal very rapidly and suppuration has occurred in the adductor cavity on three occasions only, despite the insanitary position of the wounds and the number of operations performed; for instance, in 1890 I operated on 27 patients, and this may be taken as a fair index of my yearly return. At the end of three months the splint is taken off during the day and movements are sedulously practised. For some weeks stiffness exists and often the movements are at first painful, but after a time (always shortened by vigorous exercise) the pain disappears and the effort must be made to walk.

"The splints are of a simple kind, designed to keep the knee from bending. The boots should be made of felt with substantial soles. The nurse should be instructed to keep both boots and splints upon the patient day and night, and, for the first two weeks, frequently during the day, abduction, adduction, flexion and extension of the hips should be practised. This should be done with and without resistance. At night time the feet should be attached to the side of the bed, in order to obtain abduction. After the first few days of this later stage of treatment the splints should be removed twice a day and the muscles well massaged, and both active and passive movements of ankles, toes, knees and hips, encouraged. Any movement executed in a jerky style should be practised until perfected.

"The little patient may now try to walk. It will be noted that one of the difficulties of an untreated spastic when he tries to walk, is the narrowing of the pedestal upon which the trunk rests by reason of adducted limbs. Operation has now overcome this, and with abducted limbs the body is poised upon a pedestal that is widened. During early straining the nurse must see that while walking the limbs are not approximated, and that from the first swinging, aided by crutches, must be prevented. Crutches should not be allowed until the patient has been taught to stand unsupported. I need not enter into any more details regarding this most important stage of treatment, but would add that it affords an inexhaustible field for ingenuity, and that upon the intelligence and industry of the nurse very much depends.

"I cannot now deal with individual cases, but I may say that I have operated upon cases from 12 months to 20 years of age. A large number of these were so bad that they had never attempted to place one foot before the other. Some were structurally flexed (contracted) at ankle, knee and hip. A most helpless youth of 20, one limb across the other, was able in six months to stand erect and walk with sticks, and twelve months later was able to move his limbs north, south, east and west with hardly an appreciable jerk. Success in an ancient case where so much has to be unlearnt, and where the mechanical stage offers so much difficulty, proves the soundness of the principles I have endeavored to expound. It is logical to infer that if old neglected cases are amenable to surgical education, our prognosis should be very hopeful in the young.

"With regard to the degree of benefit to be divided from treatment, the parents should be given to understand that, under favorable conditions of

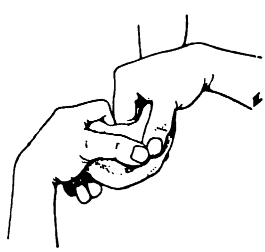
nursing and tuition, the child, aided by the hand or sticks, will be able to walk distances in from twelve months to two years, and that with perfectly straight limbs and heels on terra firma. A large proportion of cases will, later on, manage aided by one stick. Even in the least successful cases parents, mostly having desparied, are full of gratitude. The mental condition of the children obviously improves when their physical defects are remedied, and they are enabled to mix with their little friends. Complete recovery in spastic paraplegia is, of course, impossible.

"It will be gathered from my remarks that the treatment of spastic paralysis should resolve itself into a system. That system involves operative, mechanical and educational stages. The treatment cannot be separated into parts. If the surgeon is not satisfied that the case is to be under his control for twelve months he will consult his reputation best by leaving it alone. Operations, not followed up by careful and prolonged after-care, give rise to disappointment and discredit. Merely dividing tendons and trusting to massage and electricity is futile and dispiriting."

Foerster's operation for spasticity and the principles enunciated by Stoffel are referred to on page 772.

CLUB-FOOT

A clear distinction must be drawn between congenital club-foot and that form which results from paralysis acquired before or after birth. In the former, when correction or rather overcorrection of the deformity has been completed



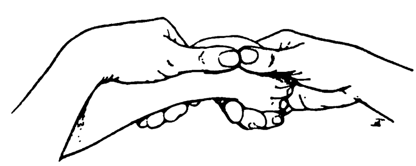


FIG. 1507. FIG. 1508.
FIGS. 1507 AND 1508.—Manual correction. (*Berger and Banzet.*)

and established, all has been done; in the paralytic form *after* deformity has been corrected it may be necessary to resort to tendon transplantation, etc., before a satisfactory result is obtained.

Congenital Club-foot.—*Talipes Equino-varus.*—Many cases of equino-varus may be successfully treated without operation if taken early enough. If an intelligent mother or nurse by manipulation endeavors to mold the deformed foot into good shape (unwind the deformity), and does this patiently 3 or 4 times daily, a cure will often be obtained. Figures 1507, 1508, 1509, 1510, show how the modeling, molding, or unwinding ought to be done. In other cases the surgeon may attain the same result more rapidly by forcible rectification (in one or more sittings), and by keeping the foot in the corrected or overcorrected

position by means of a plaster-of-Paris dressing until the new position is well established.

A cardinal rule is that overcorrection must be obtained, otherwise relapse is the rule; but overcorrection is not all. "*No case of club-foot is cured until the patient can voluntarily raise his own foot from the deformed into the over-corrected position.* There are three causes of so-called relapse in club-foot: (1) Insufficient correction of deformity. (2) Erroneous deflection of body weight

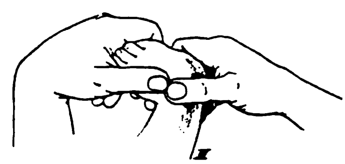


FIG. 1509.—Manual correction. (*Berger and Banzet.*)

on tarsus when walking. (3) A slack and lengthened condition of muscles due to overstretching" (Robert Jones).

Forcible Rectification.—The necessary force may be applied either by the hands or by a wrench. Tenotomy of the tendo Achillis is usually, and of the plantar fascia frequently, a necessity immediately before the forcible rectification.

Manual Rectification.—*Step* 1.—Grasp firmly in one hand the heel and ankle, in the other the distal end of the foot, leaving the region of the calcaneo-cuboid articulation unsupported by the hands. Lay the convex surface of

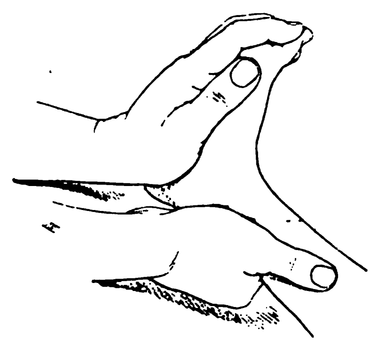


FIG. 1510.—Manual correction. (*Berger and Banzet.*)

this portion of the foot against the edge of a wedge of wood covered by a tow The wedge acts as a fulcrum (Fig. 1511).

Step 2.—Apply force, even the whole weight of the body, to straighten unfold the foot by compressing its convex side against the fulcrum and stretchi or tearing the structures on the concave side. In young cildren overcorrecti is often possible in one sitting. Care must be taken not to tear the skin. the skin seems about to tear, put off further correction until another tim when it will be found to have accommodated itself to the changed circumstance

If the desired result is not obtained in one sitting, a second, third, or fourth operation should be done at intervals of about a week.

Before the anesthetic is discontinued, envelop the foot in a plaster-of-Paris dressing. To avoid trouble from swelling of the foot owing to the trauma it is well to keep the limb elevated for twenty-four hours.

Remember that Overcorrection is the Aim.—Ridlon always uses forcible rectification with tenotomies, and division of fascia and ligaments as may be

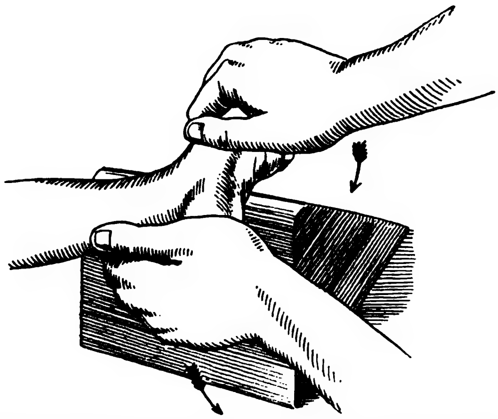


FIG. 1511.—Manual correction over wedge. (*Hoffa.*)

required. He says, "Put on thick layers of cotton batting with bandage over—this must be smooth, so as to prevent ridges being formed on inside of the plaster which is now applied *thick*—so thick that patient may walk on it for four or five months. Don't change the dressings. Don't operate before the walking age. Sometimes the thick bandages will come off, *i.e.*, slide off. If this is the case, smoothly pad the lid of a cigar box fashioned to shape of sole and fix it to the foot by adhesive straps, then apply the plaster. The whole foot and leg is wrapped

FIG. 1512.—Thomas's wrench.

with the cotton before the wood foot-piece is applied. The plaster goes to about the knee and must be thick. The test of cure is that when the plaster cast is removed the foot remains in overcorrected position and cannot without force be put into malposition. Operate at any age."

Instrumental Rectification.—The best instrument for applying force in the rectification of club-foot is Thomas' wrench (Fig. 1512) employed as Thomas used it. The wrench is applied to the foot and the foot is twisted and bent in the normal directions. The correction must be accomplished forcibly and

quickly and the foot immediately released. Holding the foot too long in the bite of the wrench may result in a pressure sore (Ridlon and Jones). Apply force sufficiently to temporarily destroy the resiliency of the soft parts so that the foot lies lax in the hand of the operator. Place in good position in a retention brace. After a few days the resiliency of the soft parts begins to return and the operation is repeated if this is necessary to obtain overcorrection, until there is no tendency towards recurrence. After this keep the foot immobilized until all the parts have adapted themselves to their new relations; or, as Thomas said, "until the slack has been taken up and the flexors and evertors of the ankle voluntarily act." Ridlon writes: "If the patient cannot voluntarily flex and evert, it is

FIG. 1513.

FIG. 1514.

FIGS. 1513 AND 1514.—Jones' club-foot splints. (*Jones.*)

because the tendons concerned are still suffering from stretch palsy, and relapse will occur exactly as deformity arises in poliomyelitis. (Figures 1513, 1514, 1426, show the application of R. Jones' iron club-foot splints.)

In some obstinate cases of club-foot the tendo Achillis pulls upwards on the *inner* side of the tuberosity of the calcaneum to an unusual extent and thus hinders or prevents correction of varus. Under these circumstances R. Jones by transplantation moves the insertion of the tendo Achillis outwards in the following manner: Expose the tendo Achillis by a T-shaped incision (Fig. 1516). Split the tendon longitudinally. Separate the inner half of the tendon from its insertion. Pass the inner segment of tendon (now a flap with pedicle above) under the outer (Fig. 1517) segment and suture its free end to the periosteum of the os calcis outside and in immediate juxtaposition to the still attached half. The opposing surfaces of tendon should be vivified and sutured together.

Phelps' Operation.—**Preliminary Treatment.**—If the patient has walked, large callosities will be present on the foot; to soften and clean these soap poul-

tices should be applied for twenty-four hours; twelve hours before the operation the foot must be thoroughly scrubbed and an antiseptic fomentation applied.

Step 1.—Render limb avascular by elevation and apply tourniquet. Place

FIG. 1515.—Application of Jones' splints. (*Jones.*)

the foot, with outer side downwards, on a sand-bag. Have the assistant hold the heel firmly. Grasp the distal portion of the foot and make the plantar tissues tense.

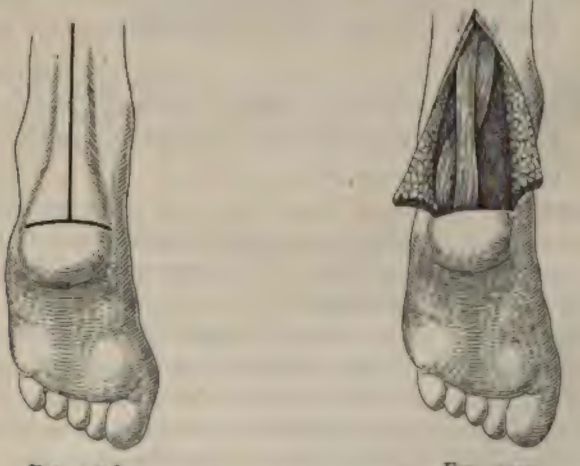


FIG. 1516. FIG. 1517.

FIGS. 1516 AND 1517.—Jones' transplantation of insertion tendo Achillis.

Step 2.—On the inner side of the foot make an incision beginning directly in front of the malleolus and ending one-fourth of the distance across the sole of the foot. Divide *all* resisting structures, penetrating to the bone if necessary. (See Fig. 1518; here the cut is being made from the sole to the malleolus.)

Step 3.—By manipulation complete the overcorrection of the varus.

Step 4.—Correct the equinus by a tenotomy of tendo Achillis.

Step 5.—Pack the wound with sterile iodoform gauze. Dress. Immobilize in a position of overcorrection by a plaster-of-Paris bandage, which reaches well up the calf. While the plaster is hardening, hold the foot in its new position by means of a flat board laid against the sole.

Step 6.—Remove the tourniquet. Elevate the limb for twenty-four hours. If cleanliness has been attained, the dressings may be left untouched for from two to three weeks, when the wound will generally be found practically healed.

FIG. 1518.—Phelps' operation.

Tarsectomy.—Occasionally the above operation may be found insufficient to produce overcorrection. Having divided the soft parts as described, cut through the neck of the astragalus with a chisel. In packing the wound do ***not*** introduce the gauze into the cleft in the bone.

After-treatment.—Plaster of Paris, renewed when necessary, should be worn for from six to eight weeks, after which massage and exercises should be used and a good strong shoe worn. As a rule, no special club-foot shoe is necessary after the Phelps operation.

Jonas's Operation.—A. F. Jonas ("Annals of Surg.," April, 1899) thus describes his method: "An incision is made, beginning slightly below the margin of the plantar fascia on the inner side of the foot, at a point on a line directly below and anterior to the internal malleolus, extending forwards and upwards to a point on the first metatarsal bone and nearly to the metatarso-phalangeal articulation. A second incision is made, beginning at a point over the astragalo-scaphoid articulation, extending forwards and slightly downwards, joining the first incision near the metatarso-phalangeal joint, forming a V (Fig. 1519). The incisions are made deep, so as to include the subcutaneous tissues and fat." Dissect back the flap thus outlined. Sever ***diagonally*** the inner fasciculus of the plantar fascia. Divide the remaining structures successively, as directed

y Phelps. Do not injure the astragalo-scaphoid capsule. Make another ncision on the outer side of the foot over the head of the astragalus, and with chisel divide the neck of that bone, if necessary, removing the head. Over-orrection is now easy. Ligate the bleeding points. Replace the traingular lap (Fig. 1520). Do *not* suture. Cover the wound with perforated oiled silk. Dress. Immobilize in a plaster-of-Paris bandage which reaches one-third up the high. Leave dressings undisturbed for five or six weeks. This method is nly suitable in "old, inveterate, and relapsing cases."

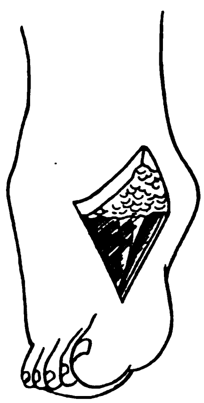


FIG. 1519.

FIG. 1520.

FIGS. 1519 AND 1520.—Jonas's operation. (*Jonas.*)

Lorenz (König, "Lehrbuch der speciellen Chir.," iii, 809) gives the following ist of operations for club-foot, in which the bones are attacked:

(A) Osteotomies.

(1) Linear division, navicular bone from the sole (Hahn).

(2) Linear division, tibia and fibula above the ankle.

(B) Enucleation.

(*a*) Of one bone:

(3) Of the cuboid (Solly).

(4) Of the astragalus (Lund, Mason).

(5) Of the astragalus with resection of the point of the external malleolus (Mason, Ried).

(6) Curettement of the spongy part of the astragalus, leaving the articular surfaces intact (Verebély).

(7) Of the astragalus plus removal of a wedge with base external from the anterior process of the calcaneum (Hahn).

Meussel's operation of extirpation of ossifying centres of the astragalus in oung children.

(*b*) Of several bones.

(8) Enucleation of astragalus and cuboid (Hahn, Albert) and of the navicular bone (West).

(9) Enucleation of the navicular and cuboid (Bennet).

(C) Resections.

(10) Of the head of the astragalus (Lucke, Albert).

(11) Of a portion of bone from the external half of the neck of the astragalus (Hueter).

(12) Resection of a wedge from the outer and upper sides of the tarsus (O. Weber, Davis, Colley, R. Davy, Schede, Meussel, etc.).

(13) Resection of two wedges perpendicular to each other with their bases directed outwards from the astragalo-calcaneal and Chopart's joints (Rydygier).

Occasionally the fibula occupies a position too far back near the tendo Achillis, the space between the internal and external malleoli is too narrow, and the anterior portion of the astragalus is too wide. This state of affairs is an indication for excision of the astragalus (König).

Astragalectomy.—1. Apply an Esmarch bandage.

2. Make a longitudinal, slightly curved incision 2 inches long over the most prominent part of the head of the astragalus from the external malleolus downwards and inwards between the outermost tendon of the extensor longus digitorum and the peroneus tertius. Reflect the soft parts with a periosteal elevator.

3. Open the ankle and astragalo-scaphoid joints. Seize the bone with a lion-jawed forceps, loosen it with an elevator, and divide its ligaments with strong, blunt-pointed scissors or the scalpel.

4. Place the foot in good position. If correction cannot yet be obtained, one may follow Walsham's advice (Jacobson's "Operations of Surg.," ii, 711): "When once a bone operation has been embarked on, it is no use stopping short till sufficient bone has been cleared away to permit of the rectification of the foot. No more should, of course, be removed than is necessary, but to take away too little is to my mind the graver fault.

Cuneiform Tarsectomy.—The operation of cuneiform tarsectomy consists in making a longitudinal incision over the most prominent portion of the tarsus, without injury to the tendons, in reflecting the soft parts to lay bare the bone, and in excising a wedge of bone. The steps of the operation do not require description; the surgeon must apply Walsham's rule, quoted in the previous paragraph, and also make use of common sense.

Ogston's Operation ("Brit. Med. Jour.," June 21, 1902).—This operation is similar to that of Meussel, and is suitable in bad cases of club-foot in children up to the sixth or possibly the eighth year. A skiagraph will tell if ossification has proceeded too far. The principle of the operation is to remove the osseous centres from those bones which impede rectification. After correction, the remaining envelope of cartilage will become ossified. "An incision through the skin is made in a gentle curve, beginning in front of the external malleolus and extending forwards with its convexity towards the sole, until it terminates over the calcaneo-cuboid joint on its dorsal aspect. When its edges are retracted,

the outline of the astragalus is visible. The soft parts covering it and the cartilaginous shell surrounding its osseous centre are then divided by a shorter incision in the same line as the cutaneous one, the knife being made to sever everything down to the bony kernel. A Volkmann's spoon, slightly curved forwards at its neck is passed into the wound of the cartilage, and its whole bony centre, save the upper part constituting the pulley between the two malleoli, is cautiously scraped out." If necessary, the same treatment may be applied, through the same external wound, to the cuboid and anterior end of the os calcis. After removing the Esmarch constrictor and attending to hemostasis, close the wound with deep and superficial sutures and immobilize with plaster of Paris in correct position.

The following remarks are based on material placed at the disposal of the writer by his friend, Mr. Robert Jones, of Liverpool.

Before any bone operation is adopted in club-foot one should, at a preliminary sitting, correct the deformity as much as possible by means of the tenotome and wrench. Less bone will then have to be removed and the result is much more artistic.

In club-foot there is often present a twist in the leg. This rotation is entirely below the knee and confined to the tibia and fibula. Unless this deformity is corrected there will be persistent trouble even after complete correction of the equinus and varus. "It is therefore well to anticipate this problem the moment we begin treatment. Every time the Equino-varus is manipulated the malleoli should be grasped in one hand, while the leg should be held below the knee with the other. The lower ends of the tibia and fibula are rotated outwards and the knee inwards. The leg is thus twisted on its long axis by an action not dissimilar to that used when one wrings a wet cloth. If this is done each day, by the time the foot is straight the inversion of the foot will also have disappeared. No club-foot can be pronounced cured until the patient walks. Walking is the act which completes the cure."

Sometimes osteotomy or osteoclasis is necessary to correct the twist in the tibia and fibula.

Mr. Jones sums up his practice in the treatment of club-foot in the following words:

"The operation I perform in obstinate cases is very simple and can be completed in about ten minutes.

"(*a*) The removal of half the scaphoid.

"(*b*) The removal of anterior and lower part of astragalus leaving the tibial articulation.

"(*c*) Osteotomy, if necessary, through outer part of tarsus.

"(*d*) Forcing foot into everted position when the scaphoid will articulate with the remainder of the astragalus.

"The simple case is one which we can quite easily replace in good position and which shows but little, if any, adduction at the mid-tarsal joint. Such a case will probably not require a division of even the tendo Achillis. If, however, there is marked adduction at the mid-tarsal and a rotation inwards of the tibia

and fibula, the case may be looked upon as affording the surgeon an opportunity for work. In the simple case, where the surgeon cannot pay frequent visits, the nurse should be taught the manipulations which she can practise several times a day. The tibia and fibula should be grasped at the epiphysis which may otherwise easily be separated, and the foot should be alternately everted and flexed. Following this, the heel should be grasped in one hand and the anterior portion of the foot in the other and abduction secured at the mid-tarsal joint. Five minutes spent three times a day in doing this should be followed by gentle massage of the flexors of the foot and the peroneal group. This should be followed by the application of a bandage or of a rectangular splint. Surgeons often fail to appreciate how much can be done by the simple application of a calico bandage. If the surgeon desires to turn the foot in, he should start the bandage on the outside; if he desires to evert the foot he should begin on the inside. In the case of eq. varus he should start on the inner side of the ankle, pass under the sole of the foot, over the front of the ankle and so evert it. Every turn of the bandage so applied pulls the foot outwards, whereas, if the bandage be started from the outer side, the deformity is at each turn increased. I have on several occasions, for demonstration purposes in club-foot of moderate severity, quite overcome and cured the deformity by the simple expedient of a bandage. Care should be taken if a bandage be used, with or without a splint, not to carry it much above the ankle lest the muscles be thereby weakened (Fig. 1521). Should the surgeon be able with but little effort to restore the foot to its normal position, it will not be necessary to divide a tendon. Should the degree of resistance be more marked, division of the tendo Achillis becomes imperative. A great deal has been written of the advantage of correcting the varus before dividing the tendo Achillis. Although in full possession of the arguments for this view, I quite fail to appreciate their force, and on the contrary maintain that the Achilles tendon often helps to perpetrate the inversion.

"**The Club-foot Shoe.**—I use a club-foot shoe which I have modified from the Thomas. The details of its application, simple as they appear, require study. It can be made by any country blacksmith at a very trivial cost. It is made of flexible sheet-iron (Figs. 1513, 1514, 1515). After the foot has been manipulated into the best possible position, a piece of plaster should be started on the dorsum, passed under the sole, and given to an assistant at hand. He should be directed to pull at right angles to the leg, while the surgeon places the retention splint in position. This should be done for fully six weeks, either by the surgeon or someone he can trust; the splint being changed every day. I very much prefer this method of retention to that of plaster of Paris which I rarely use. At the end of two months the most troublesome of this class, *i.e.*, cases which the surgeon sees during the first two years, will present a pliable foot which can be placed into normal position without encountering resistance, and if the child be sufficiently old be can be taught to walk in such a manner that each step he takes tends to improve the shape of the foot."

Talipes Calcaneus (Congenital).—In this form of club-foot the foot is in a position of dorsal flexion; the tendo Achillis is elongated, the anterior tendons

are contracted. It is wise to begin treatment by manipulation a few days after birth. The manipulation consists in patiently and persistently coaxing the foot into a position of plantar flexion, thus stretching the anterior tendons. As soon as the deformity has been *over*corrected, apply some fixed dressing to retain the overcorrected position until the tendo Achillis has had time to contract. In severe cases the manipulation may be carried out forcibly under an anesthetic. Tenotomy of the anterior tendons is very rarely necessary.

Talipes Cavus (Hollow-foot).—The arch of the foot is unnaturally high; the anterior part of the foot being approximated to the heel. The worst samples of the deformity are those produced as a mark of beauty in the Chinese women of high rank. Talipes cavus may occur along with the other forms of

FIG. 1521.—Treatment of club-foot by bandages. (*Jones.*)

club-foot. Operation is only required in severe cases and consists of subcutaneous division of the plantar fascia, forcible rectification and retention in a plaster-of-Paris dressing, until such time as the corrected position is established. Ducroquet ("La Presse Med.," July 23, 1910) finds that in *talipes cavus* associated with equinus the foot can be extended (dorsal flexion) to a right angle with the leg but cannot be flexed. When the foot is at a right angle to the leg the inferior surface of the first metatarsus makes a prominence on the sole of the foot. The great toe is hyperextended on the metatarsus. Ducroquet believes that it is the lowering of the distal end of the first metatarsal which gives the foot its hollow form, and that this lowering of the first metatarsal and the hyperextension of the corresponding toe, are both due to paralysis of the short flexor of the toe permitting the long extensor of the toe to overact. Hence he operates as follows:

1. Make a longitudinal dorsal incision from the middle of the first metatarsal bone to the middle of the proximal phalanx of the great toe. Expose the long

extensor tendon. Divide the tendon. Suture the proximal tendon stump the distal part of the first metatarsus. Close the wound.

2. Correct the rest of the deformities in the usual manner by subcutane division of the plantar fascia; tenotomy of the tendo Achillis, etc.

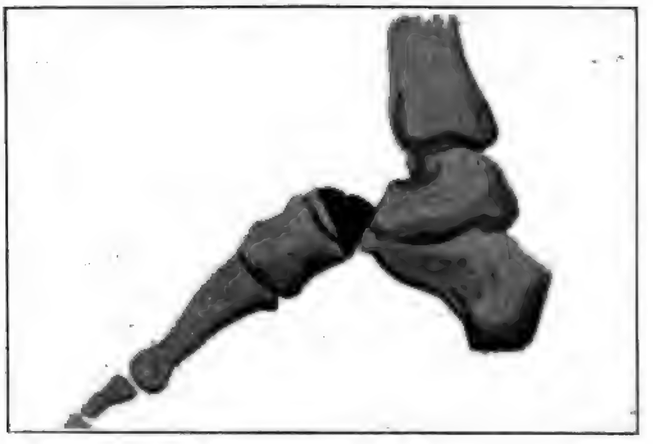


FIG. 1522.—Jones' operation talipes calcaneo-cavus. (*Jones.*)

Arthrodesis for Paralytic Calcaneo-cavus.—Robert Jones' Operation.

I. Paralysis of the calf muscles is complete.

Operation in two stages, four weeks intervening.

Stage I.—*Step* 1.—If the plantar fascia is contracted, divide it subcutaneo and straighten the sole as much as possible by manual or instrumental forc

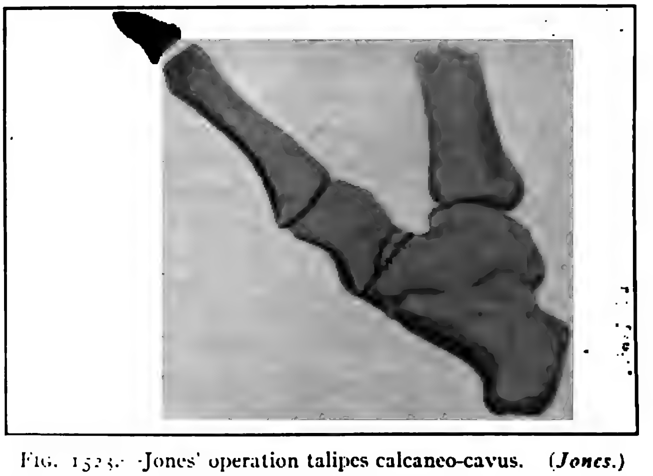


FIG. 1523.—Jones' operation talipes calcaneo-cavus. (*Jones.*)

Step 2.—On the inner side of the foot make a 3-inch incision to the bone centre of the cut being opposite the angle of convexity. Separate the parts from the tarsus with an elevator until the inner, dorsal, and pla surfaces are accessible.

Step 3.—With a chisel remove a wedge of bone (base above) (Fig. 1522) ›bert Jones, "Am. Journ. Orthop. Surg.," April, 1908) large enough to com- :ely correct the cavus.

Step 4.—Close the wound. Correct the cavus by flexing the foot dorsally

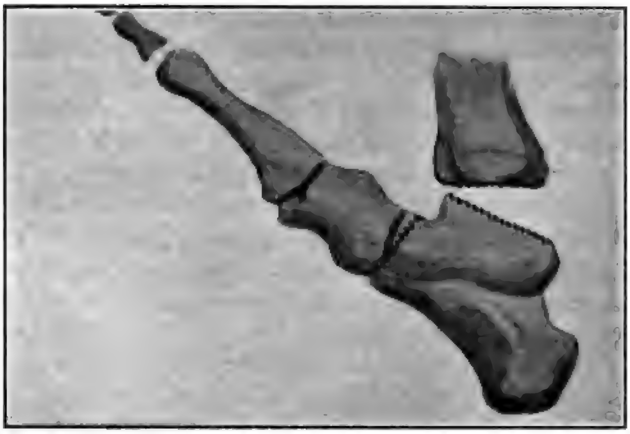


FIG. 1524.—Jones' operation talipes calcaneo-cavus. (*Jones.*)

;. 1523) and after applying dressings bandage the foot to the tibia. The us is cured, but the calcaneus is apparently much worse.

Stage II.—(Four weeks later.)

FIG. 1525.—Jones' operation talipes calcaneo-cavus. (*Jones.*)

Step 1.—Make a longitudinal cut at the back of the heel, the centre being ›osite the ankle-joint. Open the joint.

Step 2.—From the astragalus cut away a wedge of bone sufficient to permit foot being brought at a right angle to the leg (Fig. 1524) and arthrodese to ia.

Step 3.—Close the wound. Correct the deformity (Fig. 1525). Apply dressing. Immobilize until union is complete.

2. The paralysis of the calf muscles is not complete.

Stage I.—As in previous operation.

Stage II.—(Four weeks later.)

Step 1.—Opposite the ankle-joint make a posterior transverse incision long enough to expose the posterior capsule of the joint. Reflect the skin upwards and downwards. Place and hold the foot in good position. Shorten the elongated posterior capsule by throwing it into folds and fixing the folds by sutures.

Step 2.—Shorten the tendo Achillis.

Step 3.—Excise enough skin from the upper and lower edges of the transverse incision so that when sutures are introduced and healing has taken place the skin itself will aid in maintaining the correct position.

Step 4.—Apply dressings. Immobilize. After three weeks begin massage of the gastrocnemius. "For some weeks after walking has commenced the foot should be protected against strain."

CHAPTER CX

CONTRACTURES

Dupuytren's contracture is due to a contraction of the palmar fascia whereby the fingers become fixed and incapable of extension. The ring finger is first affected. The fascia is normally connected by bands with the skin of the palm. When the fascia contracts, the skin, being adherent to it at points, is naturally thrown into wrinkles and folds. Operation is indicated when the deformity causes distinct disability. In a handicraftsman operation will be called for at a much earlier stage of the disease than in one whose work does not demand free use of the hands.

Adam's Operation.—Clean the hand thoroughly. Note the points where the skin is *not* closely adherent to the subjacent fibrous band. At such places introduce a fine tenotome between the skin and the fibrous band. Turn the edge of the tenotome against the fibrous hand. Make the band tense by extending the affected finger, and at the same time give a slightly sawing motion to the tenotome. Be careful *not* to cut too deeply lest the flexor tendons be injured. The operation must be repeated at several points. Apply aseptic dressings. Fix the hand and fingers in a position of extension by means of a dorsal splint. After the lapse of three weeks careful and thorough massage is indicated; the splint may be discarded during the day, but a suitable appliance to maintain extension must be worn at night for several weeks.

Recurrence of the trouble often takes place, but in other cases the result is permanent and various nodes of scar tissue or callosities disappear in a surprising manner. The operation is simple, can be performed under local anesthesia, and ought to be tried in most cases before more severe measures are adopted.

Dupuytren's Operation.—Cleanse the hand thoroughly. Extend the affected finger as much as possible. Make a transverse incision one inch in length opposite the metacarpo-phalangeal joint. This incision divides both the skin and the contracted fascia, but *must not* injure the flexor tendons. Apply aseptic dressings. Fix the hand and fingers in a position of extension by means of a suitable splint. When the wound has healed, the treatment to be adopted is the same as after the Adam's operation.

Open Operation, Hardie's Operation.—"An incision begun half an inch above the principal transverse fold of the palm, immediately over the tense bridle of fascia, proceeding to the finger mainly involved. This is carried along the bridle to a little beyond the base of the last phalanx which is affected. The lips of the incision having been opened up, the knife is then carried close to bridle along its whole extent so as to separate from it the adjacent skin, cellular tissue, and fat, first on one side and then on the other. In doing this it is

necessary to go some depth near the upper end of the incision, so as to divide the little bands which attach the web of the finger to the processes of fascia inserted into the sides of the first phalanx." Cut across the tense fascia at the digital end of the incision. Make further transverse incisions opposite the middle of the first and second phalanges as may be required. Divide the fascia transversely wherever it seems to prevent complete extension of the finger. Isolated portions of fascia *may* be removed if convenient. Close the wound with sutures after attending to hemostasis. Apply aseptic dressings and bandage to a straight splint. After the wound has healed, make use of massage and retain the splint for two or three weeks.

Excision of the Diseased Fascia.—Complete excision of the diseased fascia is impracticable, but an extensive excision is both practicable and beneficial. Several methods of operating have been devised. Some surgeons advise the formation of a V-shaped flap having its base towards the fingers; others advise a straight longitudinal incision over the most prominent cicatricial band. Each method is proper in suitable cases. Whichever incision is used, the scar tissue is exposed as completely as possible by reflecting the skin in the manner described in Hardie's operation. The cicatricial tissue is divided at its insertion into the phalanges, carefully dissected from the subjacent structures, and removed if possible in one piece. Hemostasis is attended to and the wound closed. If the V-shaped incision has been used, the flap thus formed will generally be found incapable of completely filling the bed from which it was removed, so that it is necessary to close the proximal end of the wound as if it was a linear incision. The resulting scar is Y-shaped.

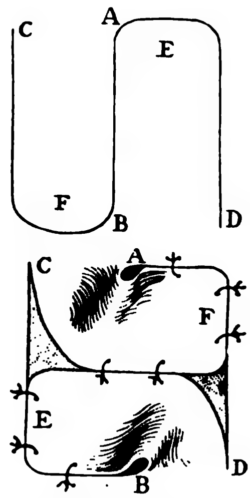


FIG. 1526.—Griffith's method.


FIG. 1527.—Lotheisen's operation.

J. D. Griffith excises the cicatricial tissue through a longitudinal incision as described above, but instead of at once closing the wound, he adopts the following procedure: From the end B (Fig. 1526) of the longitudinal incision

A B he makes the curved incision B C through the skin, and thus forms the flap F, with its base A C. In the same manner he makes the flap E, having its base at B D. These flaps are reflected from the subjacent tissues and turned so that the end of the flap E covers the raw surface left by the reflextion of the end of the flap F, and the end of the flap F covers the raw surface left by the reflextion of the end of the flap E (Fig. 1526). Whether the transposition of the skin-flaps is of much value or not, the method has given good results in the hands of Griffith, and in one case in which the author used it the result seemed excellent. In most cases, however, any attempt to transpose the skin-flaps is unwise, as the skin is so thin and ill-nourished that death of the flaps is very likely to ensue.

Lotheissen's Operation.—("Centralblatt f. Chir.," 1900, No. 20.) Make the curved incision A, B, C (Fig. 1527). Reflect the palmar flap thus outlined. Excise the palmar aponeurosis. Extend the fingers. Replace the flap. With the fingers extended there will be a small defect (AB) where the edges of the wound do not come together. Apply sutures as shown in the figure. The Esmarch bandage is used to permit of bloodless, careful dissection. Before the flap is replaced, hemostasis must be most carefully attended to, as a subcutaneous hematoma or the application of a compressive dressing endangers the vitality of the flap.

Volkmann's Contracture.—Shortening of forearm to obviate effects of the contracture.

Step 1.—Make an incision for 13–14 cm. (5–5½ in.) upwards from the base of the styloid process along the outer side of the radius. Separate the flexor tendons from the bone and retract them forwards and inwards along with the radial artery. Retract the supinator longus backwards.

Step 2.—Expose the radial insertion of the pronator quadratus and divide it close to the bone. Separate this muscle from its anterior and posterior connection but not from the ulna.

Step 3.—Cover the lower part of the wound with gauze. Expose and divide the insertion of the pronator radii teres in the outer surface of the middle of the radius. Endeavor to supinate the forearm. If supination is impossible or incomplete divide with a knife (hugging the median border of the radius) the radial attachment of the interosseous ligament near the middle of the forearm. This permits complete supination ("Jean Berger, Journ. de Chir.," May, 1912).

Step 4.—Excise a segment of radius ½ to 1 inch in length near the insertion of the pronator radii teres. This may be done subperiosteally with a Gigli saw.

Step 5.—On the ulnar side of the arm make an incision from about ¾ inch above the styloid process for about 18 cm. (7 inches) along the surface of the ulna. Separate the flexor tendons from the bone and pass a blunt hook from the ulnar to the radial wound so as to elevate all the soft parts anterior to the pronator quadratus. Excise the pronator quadratus completely.

Step 6.—Using as a measure the segment of radius which was excised in Step 4, excise a similar segment of ulna from a point near the insertion of the pronator quadratus. It is important that the wounds of the radius and ulna should not be at the same level.

Step 7.—Unite the two fragments of the radius by means of chromic catgu wire, or Lane's plate. Do the same with the ulna.

Step 8.—Close the wounds in the soft parts. Apply dressings. Apply moulded plaster-of-Paris splint (or any suitable splint) from well above tl elbow down to near the tips of the fingers. The forearm should be semiflexe and completely supinated. The wrist and fingers should be extended and tl thumb left free. There must be no constriction anywhere.

In a child the splint may be removed at the end of a month, though befo: that it may require readjustment and the arm may be temporarily exposed fo the use of passive movements.

Tendon lengthening, in place of bone shortening, has given some exce lent results.

CHAPTER CXI

PRINCIPLES OF PLASTIC SURGERY

Plastic operations are such as are undertaken to close up or fill defects resulting from errors in the development (hare-lip, etc.) or from the destruction of tissues by disease, operation, or accidental injury. While plastic operations are applied to each and every kind of tissue (bone transplantation, tenoplasty, neuroplasty, etc.), yet in most of them the skin plays the chief rôle.

Do not undertake plastic operations in the debilitated, or in those with active disease present (*e.g.*, suppuration, syphilis, etc.).

The two main principles at the base of all plastic work are: (*a*) Proper preparation or vivification of the tissues to be united; (*b*) thorough relief of tension. Failure to carry out these principles leads to certain disappointment.

When the defect is oval, but not very extensive, and the neighboring skin is not firmly bound to the deeper structures, the edges of the oval may be brought together directly and sutured. If on attempting approximation *tension* makes itself evident, this tension must be relieved. Tension may be relieved by burrowing with knife or scissors between the skin and the deep fascia, thus undermining the skin all around the defect (Fig. 1528). In some localities, *e.g.*, the pectoral region, very large defects may be thus obliterated. Often this burrowing must be supplemented by making a cut through the skin parallel to and on one or both sides of the defect. Such relaxation incisions should be in positions where their scar will be more or less hidden. When the defect is square-shaped, it may be closed as shown in Fig. 1529. Large defects require other means of treatment, either being closed by skin-grafting or by the use of pedunculated flaps of healthy skin, obtained preferably in the near neighborhood, occasionally from more remote parts. The skin chosen to form the flaps must be such as to match that lost. It would not gratify a patient much to have a successful rhinoplasty performed on him if the hairy scalp was used to supply the necessary skin for the nose. The objection to many of the operations for ectopia vesicæ or for epispadias is that skin capable of growing hair is used to line the new bladder or urethra. Hairless skin is often used to replace lost mucous mem-

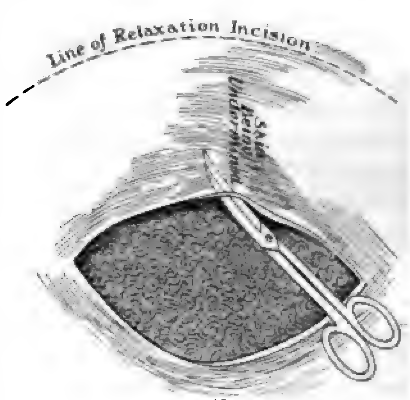


FIG. 1528.

brane, but if healthy mucous membrane can be obtained, such is far better. The flaps should consist of the whole thickness of the skin, but without too much subcutaneous fat attached to them; they ought to be about one-sixth larger than the defect they are to fill, and should have a pedicle through which nourishment is freely supplied. Twisting of or tension on the pedicle occludes its blood-vessels, cutting off nourishment and impeding the natural drainage; hence it is necessary in tracing out the flap to do so in such a position that it can be fixed in its new location without running these hazards. Part or all of a skin-flap, even with a good pedicle and with its raw surface in contact with a corresponding healthy raw surface, often fails to live. After the lapse of a few hours the surface becomes discolored, edematous, blisters form, and death of the tissues takes place. This death is *not* from want of nourishment; it is from want of

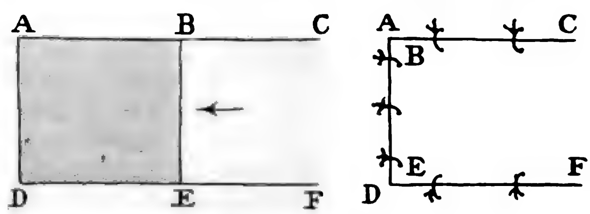


FIG. 1529.

normal absorption or drainage from the flap. The drainage is of even more importance than the nourishment obtained through the pedicle. Under similar circumstances a flap of skin completely detached from the body and implanted into a defect (Wolf's grafts) lives and does not show the above phenomena. This is due to the fact that there is no damming up of lymph in the detached portion of skin. The grafted skin soon becomes united to its new bed, thus obtaining a sufficiency, but not an excess, of nourishment. C. H. Mayo scarifies the surface of flaps which are provided with pedicles, thus providing for immediate lymph drainage and avoiding the dangers of necrosis from lymph stasis. This scarification need not be deep; mere scratches suffice.

Sometimes flaps are provided with two pedicles—"visor-shaped" flaps. A good example of this variety is seen in Regnier's operation for cancer of the lower lip.

Fear may be entertained as to the viability of a flap if it is transferred to its new site as soon as it is formed, and thus in some cases it is wise to trace out the flap, separate it from the deep structures, but leave it attached at both ends; the bridge of skin thus formed must be kept separated from the subjacent tissues by a layer of oiled silk. After about two or three weeks one of its pedicles is divided and the flap put in place (Fig. 1530). This plan (Croft) is specially suitable when the flaps required are long and narrow.

Instead of pedunculated flaps, areas of skin entirely detached from their normal connections may be used. This is truly skin-grafting. The grafts may be obtained from the patient himself, from a recently amputated healthy limb, or from obliging friends. Grafts obtained from animals (rabbits, frogs

have been employed, but when used after the Thiersch method, even if they have adhered to the raw surface, they have not reproduced epithelium and have been ultimately absorbed.

Wolf's Grafts.—Wolf, of Glasgow ("Brit. Med. Journ.," Sept. 18, 1875), devised the following method of repairing recent defects, especially in the eyelids:

On some suitable region—the forearm, inner side of upper arm, or thigh—trace with the scalpel an area of skin at least one-sixth larger than the defect to be filled and of suitable shape. Quickly and completely separate the flap outlined from the subjacent tissues. With the scissors carefully remove all fat from the under surface of the graft; in fact, trim this surface until the pale, deep surface of the cutis vera is visible. Fit the graft into the defect and hold it accurately in place, either by a few fine sutures or by suitable dressings. In the repair of defects in the eyelid the writer has often seen the Wolf graft sutured in place and protected by a few layers of gold-beater's skin, which, when dry, acts as an efficient splint to the part.

FIG. 1530.

Grafts such as above are usually employed to cover raw areas resulting from operations and not to cover granulating surfaces. It is of prime importance that hemorrhage be completely stopped, otherwise effused blood will lift the graft from its bed and prevent adhesions.

Thiersch's Graft.—Thiersch ("German Surg. Soc.," 1874, 1888) suggested the use of grafts consisting of epidermis, corresponding in thickness to the covering of a blister and cut from some suitable region in as large strips as possible. This is the most common and convenient method of skin-grafting. The grafts may be applied to a fresh wound, *e.g.*, open wound left after amputation of the breast, or to any clean granulating surface. When a granulating surface is to be covered by grafts, it must be prepared by thorough cleansing and the removal of exuberant granulations by means of rubbing with gauze or by the sharp spoon. All bleeding must have ceased, whether the wound is recent or granulating. If oozing of blood persists, the wounded surface must be covered by a protective layer of rubber tissue, silver-foil, or such like material, over which sterile gauze is applied, and the skin-grafting put off until the next day.

The grafts are generally obtained from the inside of the thigh. If the skin to be employed is hairy, shave the hair. As the portion of epidermis to be taken is too thin to contain any hair-bulbs, no hair will be grafted, no matter from what region the graft is obtained. Cleanse the area selected. With the hands, McBurney's tractor, or a paper-knife make the skin tense. Shave off the thinnest possible layer of epidermis with a very keen razor, moistened with salt solution (Halsted uses an amputation knife). This forms the graft and should be as large as possible. Carry the graft, lying in folds on the razor blade, to the wound. Keep it moist with salt solution. Hold the sharp edge of the blade close to the wound. With a needle pull the end of the graft gently on to the wound, temporarily fixing it there; as the blade is slowly pulled away parallel to

the wound the graft smoothly slips off it and lies flat on the wound. If there are any little folds in the graft, get rid of them with needles in the same manner as is done when spreading sections of tissue on the slide for microscopic work. Sometimes if the graft becomes tangled on the razor blade it is well to put it in a basin of salt solution and float it on to a piece of oiled silk. The oiled silk with the graft lying smoothly on it is laid(with the graft under) on the wound, the edge of

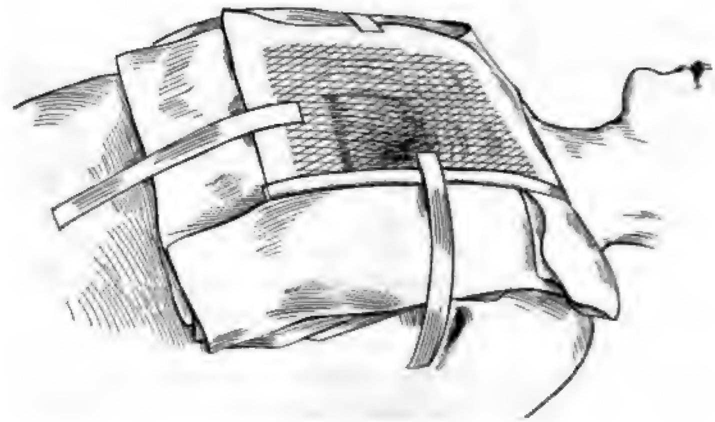


FIG. 1531.

the graft is held in place on the wound with a needle, and the oiled silk removed gently, leaving the graft in the position desired.

When the whole wound is covered with grafts, place over them strips of rubber tissue or of silver-foil, and outside this the ordinary gauze dressings. The dressings ought, if possible, to remain unchanged for a week; when they are removed, the rubber tissue or silver-foil prevents their pulling the delicate epi-

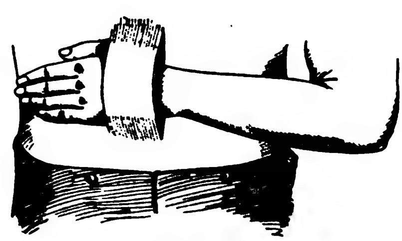


FIG. 1532.

thelium away with them. No antiseptic lotions ought to be employed, only salt solution. The same kind of dressings must be applied until the healing process is complete. Very large surfaces can be made to heal in a short time by the Thiersch method of skin-grafting.

When possible it is far better to avoid the use of any dressing or tissue applied to the grafted area which should be left freely exposed to the air. To protect the wound against flies and mechanical irritation, it may be surrounded by a thick wall of cotton or such like material which supports a roof of fine wire

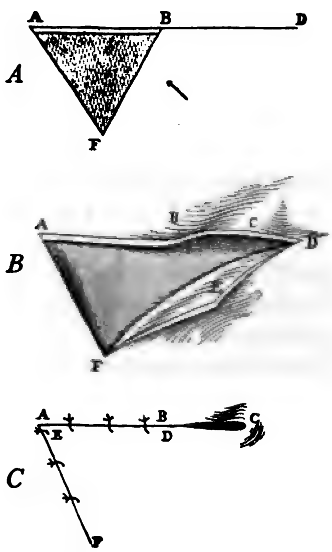


FIG. 1533, A, B, C.

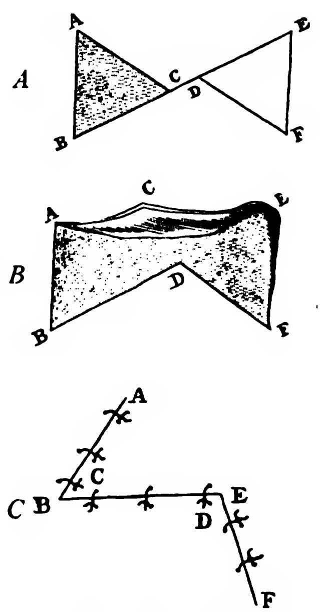


FIG. 1534, A, B, C.

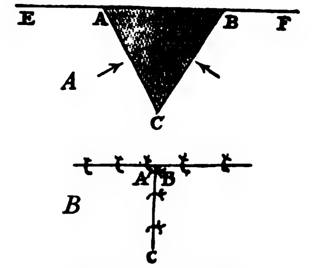


FIG. 1535, A, B.

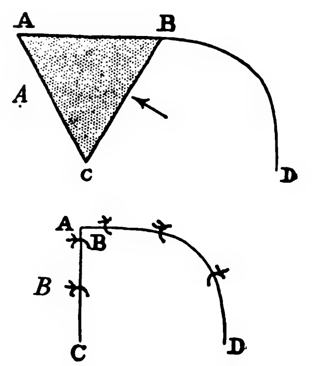


FIG. 1536, A, B.

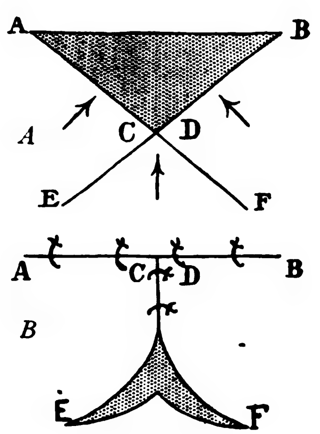


FIG. 1537, A, B.

netting (mosquito screen) (Fig. 1531). Some surgeons have advised the use of a plate of celluloid instead of the wire netting, but this prevents the desired free circulation of air.

Carl Haeberlin (Bad Nauheim) finds that all granulating wounds heal best when exposed to the direct rays of the sun (without any interposed material) for about two or three hours daily; during the rest of the day he covers the wounds loosely with gauze ("Münchener med. Woch.," 15 Oct., 1907).

The original method of skin grafting is that of Reverdin ("Soc. de Chir.," Paris, 1869). It consists in transplanting fragments of skin about the size of the head of an ordinary pin; the fragment includes a little of the *cutis vera*. Numbers of the grafts are implanted on the area to be covered and each if it lives acts as a centre for the growth of epithelium. Thiersch's method has practically displaced Reverdin's.

Denuded areas on the hand or forearm may be covered with skin by the following efficient but distinctly uncomfortable method: If the defect is on the back of the hand or forearm, chose a place on the front of the abdomen or chest where the hand or forearm may lie and be supported without too great strain. Through the skin of the trunk make two parallel incisions and undermine the skin between them, thus forming a flap with two pedicles (Fig. 1532). Push the hand under the flap and adjust and suture the flap to the denuded area. Apply dressings, and with adhesive plaster fix the hand and arm to the trunk. When union has taken place between the flap and the denuded area, divide the pedicles, close the abdominal wound in the usual manner, trim the flap, and complete its union to the denuded area. If the denuded area is on the palmar aspect of hand or forearm, the flap must be made on the back of the trunk. The following diagrams illustrate better than words a few methods by which defects can be filled by means of skin-flaps (Figs. 1533 to 1537). Special plastic operations have been considered in the sections devoted to the surgery of various individual conditions and regions.

CHAPTER CXII

METHODS OF DRAINAGE

The collection of fluids in dead spaces in wounds is potentially dangerous, and hence drainage should be provided for such spaces. Collections of pus or other noxious fluids in any part of the body require removal, usually by means of drainage. Drainage in its simplest form is exemplified by the open treatment of wounds; here absorbent dressings are applied directly to the wound surface or cavity and absorb all exuded fluids as soon as secreted. Where dressings cannot be applied directly to the secreting surfaces, the secretions must be guided to the dressings. According to the nature and surroundings of the fluid to be drained, the method of drainage provided must vary. For such fluids as serum, capillary drains suffice; for thick pus, tubular drains are essential.

FIG. 1538.

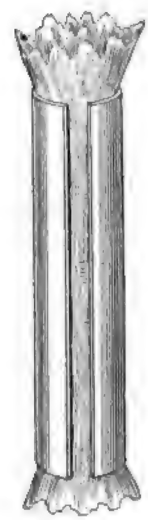


FIG. 1539.

When a collection of pus is evacuated through the peritoneal cavity, the method of drainage must provide protection to that cavity, hence a combination of tubular or capillary drainage with protective packing becomes necessary. The following are the principal means of drainage:

A. Capillary Drains.—1. *Horse-hair; silkworm-gut; catgut.* A few strands of these materials, in a bundle, act as an efficient drain for small quantities of serous exudates.

2. *Gauze or wick.* A strand of absorbent gauze or a portion of lampwick may be used as a capillary drain, but if these are left in place too long, fluids

readily coagulate in their meshes, and instead of draining, they act as a plug to prevent drainage.

3. *Cigarette drains* consist of gauze surrounded (Fig. 1538) by a sheet of thin rubber tissue which enhances their efficiency and prevents the gauze becoming adherent to surrounding structures. Instead of rubber tissue the gauze may be surrounded by a split rubber tube (Fig. 1539). Strands of woolen yarn are more efficient than gauze.

B. **Tubular Drains.**—1. *Rubber tubes.* Very small tubes are useless, as they become plugged by coagulated discharges. The most useful are those the size of an ordinary lead-pencil or of the little finger. It is rare that larger tubes are necessary, and then only in the form of split tubes covering a wick of gauze. The tubes must be perforated laterally and their distal ends should be trimmed in a fish-tail fashion (Fig. 1540). The tube may be prevented from slipping into the body by being stitched to the skin or provided with a guard in the form of a safety-pin. L. L. McArthur, after sterilizing rubber tubes, soaks them for a week or more in liquid petrolatum. This treatment makes the tubes softer and prevents clotting in them.

FIG. 1540.

2. *Split rubber tubes* are the ordinary tubes split up one side. The split renders the tubes less rigid and less liable to cause pressure necrosis.

3. *Dressed drains* consist of a rubber tube surrounded by a few layers of absorbent gauze (usually iodoform) (Fig. 1541) the gauze being in turn covered by thin rubber tissue. The dressed tube is practically a cigarette drain with a tubular core. They are of great value, especially in abdominal surgery.

4. Wetherill's drain is useful in many locations. It is prepared as follows:

Cut two holes in a long piece of drainage tubing as indicated at *A* and *B* (Fig. 1542, 1). Draw one end of the tube through *A* and out at *B*, thus inverting that portion of the tube between the holes as seen in (Fig. 1542, 2). Bend the legs of the tube down so that the holes *A* and *B* will be left open for drainage (Fig. 1542, 3). If bent in one direction they are open, if in the other, closed. Tack with a fine stitch at *C*.

5. *Rigid tubes of glass, hard rubber, celluloid*, etc., are often employed. These may be provided with a collar, made from a segment of rubber tube, through which a safety-pin or stitch may be inserted to provide (Fig. 1543) against the slipping of the tube into the wound.

FIG. 1541.

C. **Combined capillary and tubular drainage** may be effected by surrounding any of the ordinary capillary drains with a tubular drain, *e.g.*, a rubber tube containing a bunch of silkworm-gut threads.

D. **Absorbable Drains.**—The use of catgut as a capillary drain has already been noted. Neuber suggested drains of decalcified bone and Macewen introduced the inexpensive chicken-bone drain.

Preparation of Chicken-bone Drainage-tubes.—Clean the flesh off the tibiæ and femora of chickens (cooking the chicken does not injure the bone). Soak in a 20 per cent. solution of hydrochloric acid until soft. Cut off the articular ends of the bone with scissors. Raise the endosteum at one end and push it through to the other extremity along with its contents. Sterilize by boiling in a satur-

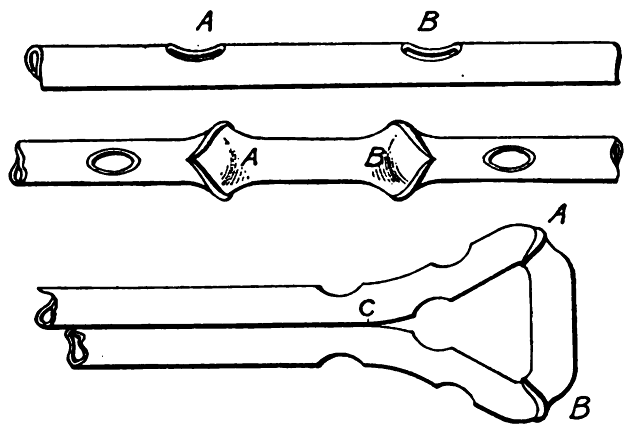


FIG. 1542.—Wetherill's Drain.

ated solution of ammonium sulphate. With sterile water or antiseptic solution wash off the sulphate of ammonium. Preserve in alcohol or in a solution of iodoform in alcohol or ether and alcohol. These tubes last for about eight days in the tissues. If greater durability is desired (*e.g.*, when they are used to drain cerebral abscesses), soak in a sterile solution of chromic acid.

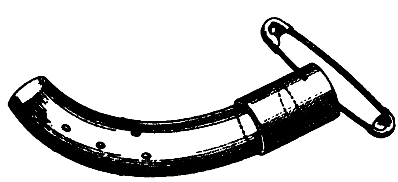


FIG. 1243.—Glass Drain with Rubber Collar.

Macewen recommends that when bone drains are used in fresh wounds they be threaded with horse-hair to prevent plugging with clotted blood and to encourage capillary drainage. After a day the hairs are removed, leaving the tube patent.

CHAPTER CXIII

ACUTE ABSCESS

Acute abscesses ought to be drained as early as possible after diagnosis. The operation should be performed under antiseptic precautions. This is important because of the danger of causing increased or mixed infection, *e.g.*, grafting a streptococcic on to a staphylococcic infection.

Local anesthesia is usually sufficient to prevent suffering. When an abscess is superficial, pass the knife steadily through the skin and subjacent tissues until pus is reached. This should be done at the most prominent or most dependent part of the swelling. As the knife is withdrawn the wound may be enlarged. A good guide as to the size of the opening to be made is the size of the surgeon's fingers. In a small and not deeply situated abscess the little finger can explore the whole cavity; in larger abscesses the index finger must be used. The opening should be made of sufficient size to admit the exploring finger.

When the abscess is deep, Hilton's method of operating is safe and excellent.

An incision about 1 or 1½ inches in length is made over the most prominent or dependent part of the swelling. The incision penetrates the skin and deep fascia. A grooved director, which must not be too sharp, is insinuated through the tissues in the direction of the pus until pus flows along its groove. The point of a narrow-bladed hemostat or blunt-pointed scissors is passed along the director into the abscess cavity. The blades of the instrument are now opened and made to dilate the opening to an appropriate size. Frequently counter-openings are required. Such may be made by passing the point of a hemostat into the abscess and pushing it out through the tissues until the skin is reached. The skin elevated by the point of the forceps is divided, the blades of the forceps are opened to enlarge the passage, a drainage-tube is seized by the forceps, and as the instrument is withdrawn, the tube is pulled into position. An abscess having been opened, its cavity ought to be douched thoroughly with warm water or a mild antiseptic solution until the solution returns clear. Any gross sloughs or masses of débris should be removed with forceps, finger, or sharp spoon. The last-named instrument should not be used too vigorously lest nature's defense against absorption, viz., granulation tissue, be too thoroughly removed, or violent hemorrhage or persistent oozing started.

Drainage-tubes must be inserted through the openings. Young practitioners often delight in the use of tubes about the size of a crow-quill; such are almost useless, as the fluid to be drained is thick and speedily chokes them. Rubber tubes which vary from the size of an ordinary lead-pencil to that of the little finger are the best; no object is to be attained by using sizes much larger. The external end of the tube must be kept from slipping into the wound, either by being stitched to the skin or by having a large safety-pin passed through it.

Bier and Klapp obtain excellent results by merely puncturing the abscess and then sucking out the pus by means of cupping glasses. In palmar abscess this treatment is specially good. The suction ought not to be vigorous enough to cause pain; it ought to be applied for five minutes and left off for two minutes alternately, for about forty-five minutes night and morning. (Bier, "Hyperämie als Heilmittel.")

J. B. Murphy instead of opening and draining abscesses, aspirates the pus and then injects formalin glycerine (formalin, 2; glycerine, 98) in quantity sufficient to produce slight tension. The solution ought to be kept at least 24 hours before being used. If a tuberculous bone lesion is present he adds 10 per cent. of iodoform to the above mixture. He employs this treatment in empyemata of the chest and of joints.

Dressings.—Ordinary, voluminous antiseptic dressings must be applied in such a manner as to collect the discharge and at the same time exercise elastic pressure on the abscess so as to keep it collapsed as much as possible and prevent reaccumulation of fluid.

PSOAS ABSCESS

Treves' Operation.—The patient is placed on his side with the diseased side uppermost. Under the opposite loin there is placed a sand-bag. An incision 2½ to 3 inches in length is made parallel to and beside the outer edge of the erector spinæ muscle (*i.e.*, about 3 inches from the spinous processes). The middle of this cut corresponds to a point midway between the last rib and the iliac crest. The dense aponeurosis covering the erector spinæ is divided throughout the whole length of the wound. The outer edge of the muscle is demonstrated and then strongly retracted towards the spine. This exposes a layer of fascia (middle layer, fascia lumborum) which covers the quadratus lumborum. By palpation find the transverse processes of the lumbar vertebræ and divide the fascia as close to them as possible. The thin quadratus lumborum muscle now comes into view, and according to Treves it must be divided close to a transverse process. The next tissue met is the psoas muscle, and when some of its tendinous fibres have been divided close to a transverse process, the finger can be "introduced beneath the muscle and gently insinuated along the process until the anterior aspect of the bodies of the vertebræ is reached."

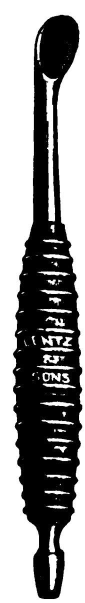


FIG. 1544. Irrigating curette.

Where there is a large psoas abscess the patient is almost always much emaciated and the tissues over the abscess are thin, so that after the quadratus lumborum muscle has been exposed, a grooved director may be insinuated into the abscess cavity and an entrance gained by Hilton's method. Having gained access to the abscess, it is thoroughly douched with hot water or a hot antiseptic solution. The writer often uses a sherry-colored solution of tincture of iodine in hot

water. The lining membrane of the abscess is to be scraped away witl finger-nail and sponge (Treves) or with the irrigating curette (Barker) (Fig 1544). This must be done cautiously, as the anterior wall of the abscess i usually thin. All pockets leading from the main abscess are explored an opened up by the finger. All accessible portions of the spine are palpated, and any tuberculous nodules are found they are, if possible, to be removed. Havir douched and cleaned and douched again, until the fluid returns clear, the cavit is dried, two or three ounces of iodoform emulsion are thrown into it, and tl wound is closed without drainage. The abscess may recur and require a secor operation.

The after-treatment consists in rest under hygienic conditions, and must l carried out for many months.

The great advantage of the Treves operation is the access it gives to tl spinal column—to the focus of the disease.

Should the abscess have opened of itself in the thigh, it must be treat on the ordinary surgical lines, *i.e.*, counteropenings must be made to provi efficient drainage.

CHAPTER CXIV

OPERATIVE TREATMENT OF NEOPLASMS

Indications for the Excision of Tumors.—It is frequently said that all neoplasms ought to be removed. The general rule is correct but, to it there are many exceptions. The warts on a small boy's hands disappear spontaneously. A lipoma or fibroma may cause little or no inconvenience, and yet be so situated anatomically that its excision might give rise to serious danger to life, or might so injure or destroy neighboring structures (nerves, etc.) as to far outweigh any benefit to be hoped from its removal. The removal of many neoplasms is a matter of choice as they are unlikely to become malignant, and excision is only sought because of their inconvenience, size or unsightliness. One must not forget that the most innocent looking neoplasm may have hidden in it the possibilities of malignancy. In other circumstances the anatomic situation of a non-malignant tumor may demand immediate operation, *e.g.*, it may cause pressure on the trachea, etc.

Warts, moles, fibromas and such, like non-malignant neoplasms of the skin and accessible mucous membrane are easily excised. It is important to remove the whole thickness of the skin with the tumor otherwise even a small wound becomes difficult to close. If the growth is large the resulting wound must be closed either by one of the methods described under plastic surgery or by skin grafting. Keen recognizing that pigmented moles often recur after excision and give rise to very malignant melanotic growths advocates their *thorough* removal. Bevan thinks that a single pigmented mole is much more likely to be the precursor of malignancy than are multiple moles.

It has been suggested that moles should be destroyed by the cautery and the resultant scar immediately excised (Bevan). The object of this is of course to prevent the disturbance and dissemination of the cellular elements of the mole. As a rule the author prefers destroying small non-malignant moles by means of carbon dioxide snow to excising them.

In excising a non-malignant neoplasm it is only necessary to remove the tumor itself, it is not necessary to "cut wide of the mark" or to concern oneself with the lymphatics.

The basal-celled epitheliomata of the face (rodent ulcer, etc.) are commonly only of local malignancy and free excision gives good results, the lymphatics not being involved at least until late. These are the tumors which are often cured by means of the X-rays.

Sampson Handley ("Universal Med. Record," 1912, p. 385) strongly urges "the inadvisability of trusting long to radio-active therapeutics as the first line of defence" even in superficial and early malignant growths "unless the disease rapidly and completely yields."

Melanoma of Skin. (Melanotic Sarcoma).—Handley is of the opinion that melanotic tumors spread by lymphatic permeation, *i.e.*, by growing into and along the lymphatic channels centrifugally in all directions, and that dissemination through the vascular system is a later phenomenon. Based on this opinion he operates as follows:

1. Make a circular incision around and about one inch from the tumor. If necessary supplement the circular incision by two radial linear incisions on opposite sides of the tumor. These cuts (circular and linear) penetrate the skin alone (Fig. 1545).

2. Elevate the skin with a thin attached layer of subcutaneous fat, from the deeper structures for a distance of about two inches in all directions from the original circular incision.

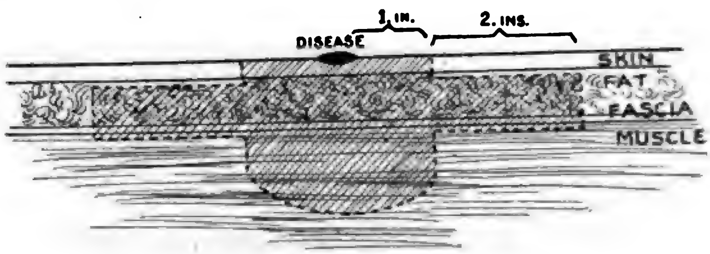


FIG. 1545.

3. At the extreme base of the elevated skin flaps make a circular incision penetrating the subcutaneous fat, the deep fascia and a few fibres of the subjacent muscles.

4. Beginning at the outer circular incision elevate the deep fascia from the muscles, dissecting towards the tumor, until a point is reached immediately beneath the first circular or skin incision. Remove the whole mass by scooping out with a knife a circular area of muscle immediately beneath the tumor.

5. Close the wound. Thoroughly excise the chain of lymph glands next in order, into which the affected area drains. The glands ought to be removed whether apparently affected or not, "and this is most important—the apparently healthy set of glands above those obviously enlarged should be completely removed." The following case of Sampson Handley's is so important and striking that it demands attention:

"Miss C., aged forty, * * * October 21, 1909. In September, 1907, Dr. Moreton Palmer removed an ulcerated papilloma which had been present on the dorsum of the left wrist for three or four years. In September, 1908, some small lumps were removed just above the epitrochlear gland. These lumps were subcutaneous and were not glandular. A week or two later, a small dark nodule appeared just below the incision. It was removed under local anesthesia and was reported by the Clinical Research Association as a malignant melanoma. Subsequently the patient suffered much pain in the bicipital region, thought to be due to an involvement of nerves in the scar. On examination I found a vague induration running up the axillary vessels about the middle of the upper arm, midway between the axilla and the scar of the second operation, and it appeared probable that the growth was recurrent in this situation.

...uld be felt in the axilla. I, therefore, ...moval of the supraclavicular glands, ...tending from the axilla almost to the ...tion and was admitted to the Boling- ...ng most of the inner aspect of the arm, ... removed with exposure of the brachial ...xt opened by a prolongation of the first ... of its fat and glands, which were removed ... the arm. The supraclavicular triangle ...parate incision. The patient made a good ... recurrent nodule appeared over the lower ...as excised on December 15, 1909, and, on ...degenerated at the centre. (It is well known ...notic sarcoma.) Since this time the patient ... which she suffered in the arm have greatly ...where she had hot sea-bathing treatment."

a towel in such a manner that they can be easily pulled out but cannot become entangled while being boiled.

Silkworm-gut.—This, the common fishing gut, is prepared from the silk-worm when it has got into condition to begin spinning. The material used is, in fact, the silk before it is spun. Silkworm-gut is an ideal, smooth, strong, non-porous, non-absorbable suture. It is easily sterilized by boiling, which at the same time softens it and renders it easy to tie. If used dry, the gut is hard and too brittle to tie. It may be obtained in various sizes, from the thick and very strong gut used by salmon fishers to the extremely fine "drawn gut" of the English dry fly fishermen.

Horse-hair possesses the advantages of fine silkworm-gut, but is better in that its elasticity prevents cutting of the tissues. It is ideal material for fine skin sutures, as it leaves little scar. It is prepared for use by a thorough washing in soap and water and then by boiling.

Silver Wire.—This is the most common suture used for uniting bones. Some surgeons use it extensively for buried sutures. Its ends are easily secured by twisting. Sterilization is effected by boiling. The metallic silver is an antiseptic *per se.*

II. Absorbable Ligatures and Sutures.—(*a*) Catgut; (*b*) Tendon.

Catgut.—The most common absorbable ligature is made from the sub-mucous coat of the intestine of sheep. The best catgut comes from Germany and Sweden. The American sheep suffer from some intestinal disease which renders their submucosa useless for the manufacture of catgut. The most convenient sizes of catgut are Nos. 0, 1, 2, 3. No. 4 is occasionally of service, but is very thick.

Catgut may be used plain or may be treated with some material which renders its absorption by the tissues more slow (chromic acid, formalin). There are a very great number of methods by which sterilization may be effected; only a few of these will be detailed here. Several manufacturers prepare reliable catgut in convenient receptacles, *e.g.*, in hermetically sealed glass tubes, in air-tight envelopes, etc. Such catgut is usually sterilized by dry heat in the fractional method. The process is more or less complicated and will not be described, as simpler and equally efficacious methods are available. The chromicized catgut of commerce is too thoroughly chromicized; it remains too long unaffected by the tissues and should be discarded. The cumol method of sterilization seems to be reliable, but requires considerable experience to be carried out in safety. Bartlett's iodized catgut is very reliable and may be obtained ready for use in tubes.

Preparation of Catgut.—Wind the catgut in a single layer on glass tubes. In doing this it is very important to rotate the tubes and, holding the gut tight, allow it to be wound on to the tube. If one twists the gut on to the tube, as it passes through the fingers its fabric is liable to become untwisted and its strength ruined. Fasten the end of the thread so that it will not come undone.

Methods of Sterilization.—(I) Elsberg's method (modified): Make a saturated solution of sulphate of ammonium in water. Boil this solution and see that

it is saturated while boiling. Boil the catgut in this for twenty minutes. With sterile forceps place the gut in sterile water or antiseptic solution to remove the sulphate of ammonium. This does not consume more than a minute. Preserve the gut in alcohol or in a saturated solution of iodoform in alcohol and ether. Elsberg before boiling soaks the gut for twenty-four hours in a mixture of chloroform and ether. This is unnecessary.

I. Claudius' method (I, KI, catgut): Soak the gut (wound on tubes) for eight days in the following solution: iodine, 1 part; iodide of potassium, 1 part; water, 100 parts. The gut is now ready, and may be used directly from the solution or after washing in sterile water or some antiseptic solution. The author prefers using it directly from the iodine solution. It is claimed that the catgut may be kept indefinitely in the solution, but this is incorrect.

Salkindsohn modifies the above in a happy fashion by using a mixture of tincture of iodine 1 part in 15 parts of proof (*i.e.*, 50 per cent.) spirit. Iodized catgut has given great satisfaction to the author.

G. G. Macdonald has tested Salkindsohn's catgut. His results are shown in the accompanying table (p. 1283).

II. Yelverton Pearson ("Brit. Med. Journ.," Dec. 25, 1909) advocates the use of "iodine-formalin" catgut when a resistant suture is desired. The gut is prepared as follows:

1. Soak in an alcoholic solution of iodine (1 per cent. iodine, 54 per cent. alcohol).

2. After eight days remove from the iodine solution and wash in a weak carbolic solution or in running sterile water "to remove the alcohol and iodine from the outer layers so as to permit more freedom for the action of the formalin."

3. Soak in 3 per cent. formalin solution for from 24 to 48 hours, according to the thickness of the gut.

4. Wash in running water for a few hours to remove the formalin.

5. Place in 50 per cent. alcohol containing ½ per cent. iodine and 5 per cent. glycerine. This preserves the gut indefinitely.

III. Iodine-acetone catgut. McDonald's method ("Am. Journ. of Surg.," May, 1910):

Sol. 1.—Iodine 4 per cent. in acetone, soak eight days, drain off solution.

Sol. 2.—Acetone, soak four days, drain off then cover with

Sol. 3.—Acetone 85 per cent., Columbian spirits 10 per cent., glycerine 5 per cent.

Dissolve glycerine in spirits then add to the acetone. Keep the gut in this indefinitely.

IV. Saul's method: Put the gut (wound on tubes) into a pot provided with a condenser. Cover the gut with a solution of carbolic acid 5 parts, 90 per cent. alcohol 100 parts. Boil for twenty minutes. Preserve the gut in alcohol or in a solution of iodoform in alcohol or alcohol and ether. Experiment shows that gut, soaked in a culture of anthrax and covered with grease, is sterilized by the above method after seven minutes of boiling.

Sterilization of Catgut by Iodine-spirit Method

Time in iodine-spirit	15 minutes	30 minutes	1 hour	2 hours	3 hours	5 hours	6 hours	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days
Commercial catgut, wound on spools and placed in iodine-spirit for varying periods, as following: (In the catgut Staphylococcus, B. prodigiosus and some sporing organisms were found by cultivation.)	Grew Staphylococcus aureus, B. prodigiosus and a sporing organism	Grew Staphylococcus aureus, B. prodigiosus and a sporing organism	Staphylococcus and sporing organism. No. B. prodigiosus	Staphylococcus and sporing organism	No Staphylococcus. Sporing organism	Sporing organism	Sporing organism	Sporing organism	Sporing organism	Sporing organism	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile
Sterilised catgut infected with Staphylococcus pyogenes aureus, as above.	....	Staphylococcus pyogenes aureus	Staphylococcus pyogenes aureus	Staphylococcus pyogenes aureus	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile
Sterilised catgut infected with Bacillus typhosus, as above.	B. typhosus	B. typhosus	B. typhosus	B. typhosus	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile
Sterilised catgut impregnated with anthrax spores. (Killed by 4–7 minutes boiling.)	....	....	B. anthracis	....	....	....	B. anthracis	B. anthracis	B. anthracis	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile
Sterilised catgut infected with spores of Bacillus mesentericus (resisted 18 minutes at 100° C.)	....	....	....	B. mesentericus	....	B. mesentericus	....	B. mesentericus	B. mesentericus	B. mesentericus	B. mesentericus	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile
Sterilised catgut (tied in skeins) infected with spores of Bacillus mesentericus more resistant than the above (being killed by 23 and not 20 minutes' boiling).	....	....	....	B. mesentericus	....	B. mesentericus	....	B. mesentericus	B. mesentericus	B. mesentericus	B. mesentericus	B. mesentericus	Sterile	Sterile	Sterile	Sterile	Sterile

(V) Chromicized catgut: Sterilize the gut by the Elsberg or Saul method Soak for twelve to twenty-four hours in a sterile watery solution of chromic aci (1:10,000). Such gut lasts from seven to ten days, according to its size. Th strength of the solution may be varied according to the ideas of the surgeon Preserve in alcohol or in a solution of iodoform in alcohol or alcohol and ether.

(VI) Formalinized catgut: Sterilize the gut by the Elsberg or Saul method Soak for twelve hours in a 1 per cent. watery solution of commercial formalir Preserve in alcohol, etc. The durability of this gut is about seven to ten day

The usual method advised for the preparation of formalinized catgut is t soak it for twelve to forty-eight hours in a 2 per cent. watery solution of forma lin, wash in flowing water for twelve hours, boil for twenty minutes in wate and preserve in alcohol. Boeckman, however, points out that the formali acting on the gut makes its surface water-proof, that the boiling water does nc penetrate the gut, and that, as a consequence, the inside of the ligature is onl exposed to a *dry* heat of 212° F., which does not sterilize.

The methods of sterilization here described have all been tested by th author and found satisfactory. In none of them is it necessary to touch th gut with the fingers from the time the sterilization begins until it is being use in operating. Any one of the methods described is as safe as the others.

Tendon.—The tendons of such animals as the kangaroo, reindeer, and whal have been much used for sutures and ligatures. Many surgeons prefer them t catgut. Sterilization may be effected as with catgut. The main objection t the use of tendon is its expense.

APPENDIX ON WAR SURGERY

BY WALTER S. SUTTON, M. D., F. A. C. S.

The principles of military and civil surgery are identical but the exigencies of war demand many and radical variations in the application of these principles. The character of the wounds, the time which must elapse before treatment can be given, the necessary transportation of the wounded, the employment as hospitals of unsuitable buildings, the frequent numerical inadequacy of surgical personnel, the prevalence of serious infections practically unknown in civil life, all these necessitate modifications in practice. The psychic condition of certain groups of patients exhausted by deprivation both of food and sleep, by hard work and by mental stress or fright, must not be forgotten as a factor in treatment and prognosis. While the organization of the Medical Service differs somewhat in different countries, it may be convenient to consider the character of the surgery which ought to be carried out: 1st, at the fighting line; 2d, in transport; 3d, at the first line base hospital; 4th, at the base hospital in the rear where the practice may approach most nearly that seen in good civil hospitals.

1. **Surgery of the Dressing Stations on the Fighting Lines.**—The objects of the work done here are (*a*) to save lives, (*b*) to forward patients to the real workshops with the least possible damage and the least possible suffering. Here it should not be forgotten that lives otherwise forfeited to hemorrhage or shock, may be saved by the use of morphine. There is room for much surgical judgment in determining how much to do and the aim should be to let all errors be on the side of conservatism. Thus in cases showing grave hemorrhage from wounds of the extremities, it is often wise to apply a tourniquet *provided* that only a short time is to elapse before the patient will arrive at a surgical base. If the patient cannot be moved to the base in a short time, then the vessels must be ligated or the wound packed even under adverse circumstances. The wounds should be treated by some simple antiseptic such as Tr. Iodine, or better by a hypertonic wet dressing such as the salt solution of Wright.

Dressings should be applied, capable of absorbing the discharges for days if necessary. At best, one must consider that the most dreaded infections have already been implanted in the depth of the wound beyond the reach of local applications.

The great function of the dresser at the immediate front is to effect *immobilization*. The imperative necessity of immobilization is self-evident in the case of fractures and joint wounds—it is almost as important in deep wounds of the soft parts since movement promotes the dissemination of infected exudates and impairs drainage.

FIG. 1546.—(*Fauntleroy, Report on the Medico-Military Aspects of the European War.*)
1. Aluminium forearm and elbow splint. 2. Aluminium foot and ankle splint.

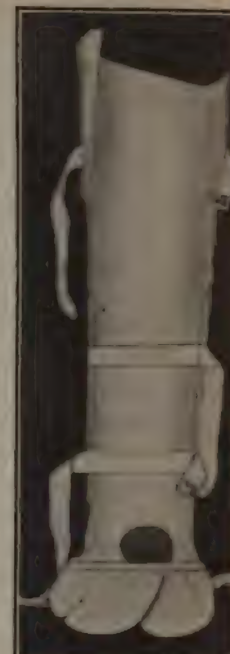


FIG. 1547.—Full-len[...] aluminium thigh and [...] splint.

FIG. 1548.

FIG. 1549.

FIG. 1548 AND 1549.—Moore's surgical dressing for fracture of the clavicle—anterior a[...] posterior views. The dressing is made of the longitudinal half of a bed sheet folded 3 pl[...]

Methods of Immobilization.—The classic makeshift splints contrived of rifles, bayonets, blanket rolls, etc., are familiar to all. For wounds of the soft parts and of joints, various military splints of woven wire are useful and, when properly padded, fit well. Stamped-out sheet metal splints which are shipped in the flat and bent to shape at the time of use, are also valuable and are easily transported (Figs. 1546 and 1547). For the upper extremity bandages, such as the Velpeau bandage or the "sling and binder may suffice." Fractures of the clavicle

FIG. 1550.—Cramer's splint.

are best treated by Moore's bandage as shown in the accompanying illustrations (Figs. 1548 and 1549). Fractures of the femur require particular consideration both because of their danger and of the difficulty in securing efficient immobilization. Unfortunately, the best splints for the thigh are too cumbersome for use at the primary dressing stations; however, an apparatus described by Töpfer (Deutsche Medicinische Wochenschrift of January 7, 1915) is so light and simple as to warrant its application even in the trenches themselves. The basis of this appliance is Cramer's the simple wire splint long familiar to surgeons

FIG. 1551.—Töpfer's splint applied to compound fracture of forearm. (*Töpfer, Deutsche Med. Woch.*)

both in Europe and America (Fig. 1550). Traction may be applied by it to the upper or lower extremity by shaping the body of the splint to conform to the member, applying countertraction bands of adhesive straps at a suitable upper point and then bending the distal end of the splint for the engagement of a traction block and screw. The former simply rests against the outer surface of the "up-turn" while the latter, terminating in a "spreader," passes between the cross wires.

It then remains to fasten the spreader to the extremity by means of adhesive

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FIG. 1552.—Töpfer's splint applied to compound fracture of humerus. (*Töpfer, Deutsche Med. Woch.*)

FIG. 1553.—Töpfer's splint applied to arm and forearm with extended elbow. (*Töpfer, Deutsche Med. Woch.*)

FIG. 1554.—Töpfer's splint applied to compound fracture of femur. (*Töpfer, Deutsche Med. Woch.*)

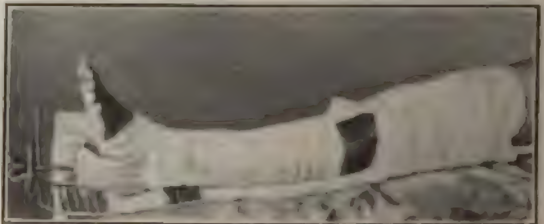

FIG. 1555.—Töpfer's splint as applied to injuries in or about knee joint. (*Töpfer, Deutsche Med. Woch.*)

straps, a laced shoe or a plaster-of-Paris gaiter and produce the necessary traction by means of turning up the screw (Figs. 1551 to 1555).

Modifications of the Thomas knee splint designed for use in thigh and humerus fractures, have been independently advanced by Robt. Jones and Jos. A. Blake and for the femur alone, by Cuthbert Wallace, C. Max Page and others.

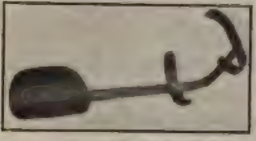

FIG. 1556.—Dorsiflexed wrist splint to secure good grasp. (*Robert Jones, British Med. Journ.*)

FIG. 1557.—Dorsiflexed wrist splint applied. (*Robert Jones, British Med. Journ.*)

For elbow and ankle wounds the splints of Robert Jones composed of curved sheet-metal plates connected by means of an iron strap are admirable and sufficiently light, compact and adaptable to permit their use at the actual front.

Whatever dressings or splints are used, the dangers of gas-infection make it imperative that all bandages be smoothly and never tightly applied.

2. **The Surgery of Transport.**—When transportation is by means of hospital ships, the work of the first line base hospital may be initiated at the beginning of the voyage, but in transportation by motor cars and trains, there is little opportunity for other than nursing measures. Moreover, efficient handling of cases at the dressing stations and a reasonable distribution of hospitals, will render more than this unnecessary. It need not be emphasized that with all wounded in transport, there should always be one or more surgeons possessed of the judgment and skill required to pack a bleeding wound.

FIG. 1558.—Splint immobilizing elbow-joint, but allowing access to it. (*Robert Jones, British Med. Journ.*)

FIG. 1559.—Elbow-splint applied (*Robert Jones, British Med. Journ.*)

Nursing measures required in this stage are: water, food, morphine, and, one might also add, cigarettes. Water for toilet purposes should also be abundant

as should a proper supply of urinals and bed pans. Sufficient blankets are essential in cold weather and enough dressing material for such dressings as require to be changed *en route*.

3. **Surgery of the First Line Base Hospital.—Infected Wounds.—Prophylaxis.**—It is well known that much of the ordinary infection and nearly all gas-infection is theoretically preventable. Pathogenic germs are not an usual accompaniment of missiles as they leave the guns, neither is secondary infection of relatively clean wounds a common incident. Infection is usually carried to the depth of wounds by clean projectiles and has its origin in the patient's immediate surroundings or on the surface of the body. A comparatively negligible percentage of wounds are made by dirty secondary missiles such as splinters

FIG. 1560.—Skeleton splint for injuries near the ankle-joint. (*Robert Jones, British Med. Journ.*)

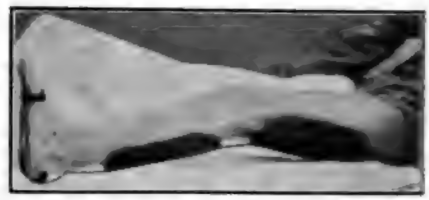

FIG. 1561.—Skeleton splint applied. (*Robert Jones, British Med. Journ.*)

of wood, pieces of rock and the like. Infection from these is hardly preventable, but the great mass of infection traceable to dirty bodies and filthy clothing stands as a reproach to present-day military surgery. Gas-infections, particularly—almost as deadly as tetanus itself—should prove preventable by efficient arrangements for personal cleanliness. The organisms are inhabitants of the intestinal tract of man and higher animals. They are found where feces and manure are found and the control of fecal contamination of bodies, clothing and soil may be expected to reduce this type of infection to a place of minor importance.

Active Treatment.—The active treatment of infected wounds consists in (*A*) removal of infected foreign bodies, (*B*) drainage, (*C*) immobilization, (*D*) the suppression of tissue infection, (*E*) mobilization and massage.

All infected wounds under four days old are to be regarded as potential gas-infections. On account of the necessity for early operation in the latter, all wounds should be carefully inspected two or three times each twenty-four hours until this time has elapsed. During this period any crust which tightly seals the wound should be removed at each inspection. There are many symptoms by which gas-infection is recognizable, but the only one which is constant and characteristic is the pathognomonic, pungent, feculent odor which, once smelled, can never be forgotten.

Recognition of gas-infection calls for immediate operation. The understanding of the methods employed requires some knowledge of the causative organisms and their activities in the tissues.

Gas-producing Infections.—The causative organisms of the gas-producing infection seen in war, are Bacillus aerogenes capsulatus, Bacillus perfringens, and their allies. These anaerobic organisms inhabit the intestinal tracts of the soldiers in the trenches and are found in the soil of the older agricultural countries. Contamination of skin and especially of clothing is universal. Fragments of clothing are regularly carried into the tissues by shell fragments and shrapnel balls, though rarely by rifle bullets. These infected fabrics being sealed off in the depths of the wound in an envelope of blood clot and devitalized tissue, form an ideal focus for the beginning of the saprophytic activities of the organisms. As shown by experiments as well as clinical observation, these gas-producing bacilli thrive best on glycogen. and in such a medium produce a maximum of gas. Their ravages are most marked, therefore, in the muscles.

Enclosed in the fascial bag formed by the muscle sheath, the pressure of the gas produces an ischæmia which renders additional muscle a fair field for bacterial invasion. Swelling proceeds with rapidity, effectually closing the wound in the fascia and in a short time the entire muscle is reduced to a red pulp or jelly. Extension may then occur to neighboring muscles through the muscle sheath or through tendons of origin or insertion, or by invasion of large vessels gangrene of the extremity may be produced. The process in military injuries frequently includes a subcutaneous emphysema and occasionally a characteristic bronzing of the skin.

(*A*) Removal of infected foreign bodies is the first indication in treatment. Shell fragments and shrapnel balls are to be found and removed whenever possible. The scraps of clothing practically invariably found in these wounds are easily recognized both by sight and touch and *must* be removed.

(*B*) Drainage implies a free communication between interior and exterior and may be made and maintained only by incisions which relieve present tension and provide for future swelling. In the case of gaseous infections, this means *long* incisions (usually longitudinal) widely opening the sheaths of all affected muscles and extending 4 or 5 inches in each direction beyond the swelling. A single incision usually suffices, though occasionally a second is required on the opposite side of the limb. Multiple short incisions are inefficient in relieving tension and usually result in extensive surface sloughing. They are to be avoided. Pulpified muscle is to be scooped out since it interferes most effectually with drainage and the entrance of oxygen, and is the optimum breeding ground for the causative organisms. The muscle sheaths, especially the fascia lata, should be freely incised transversely to relieve tension, and all dead or badly soiled edges of fascia and skin are to be cleanly excised.

Gas-infection involving only the superficial layers is readily controlled by long incisions extending to the deep fascia.

Finally the boiling out of the wound with hot peroxide of hydrogen introduced under low pressure by means of a large glass syringe has seemed to the author to be advantageous. This loosens and removes much dead matter and the nascent oxygen generated may possibly have some destructive action on the bacilli.

The maintenance of drainage is provided for by a large Mikulicz tampon which remains in place twenty-four to forty-eight hours effectually moulding the walls of the wound to an open position. The tampon may profitably be saturated as it is inserted, with the camphor-phenol-alcohol solution of Chlum-

sky. Dressings are loosely applied to avoid the constriction so helpful to gas-organisms in extending the muscle destruction by means of gas-pressure.

Seton wounds when infected should be opened throughout their length by division of the roof of the seton and should then be packed open. The time required for healing may thus be reduced fully 50 per cent.

In many cases of gas-infection, amputation is necessary.

Amputation is indicated:

(1) If extensive incision does not arrest the process in twelve hours.

(2) If the limb would be useless even after it was saved on account of

(*a*) bone destruction, or

(*b*) extensive muscle or nerve destruction.

(3) If actual gangrene has supervened.

(4) If, in an extensive infection, the strength of the patient seems insufficient to bear primary wide incision followed by amputation if necessary.

Amputation.—Amputation should be at as low a point as possible and in cases of gas-gangrene may with impunity pass through definitely infected tissue

FIG. 1562.—Disarticulation at the hip-joint for "gas-gangrene." Exposure treatment.

if it is plain that the amputating incision or a collateral one, will produce drainage. Circular amputation is the method of choice with or without a cuff of skin and superficial fascia. Vessels are ligated above any thrombi present if possible, but the author has ligated through a thrombus in the axillary vein without untoward result. Nerves are pulled down and cut high, if possible after preliminary blocking. If a cuff has been made, its cavity is loosely filled with plain, or iodoform or Chlumsky gauze. No sutures whatever are employed (Fig. 1562). After a few days, traction is applied to the soft parts by means of adhesive plaster or canton flannel glued* to the skin with the result

* The formula for the glue used in this and other forms of traction, is as follows:

Powdered resin	50
Alcohol	50
Benzine	25
Venice turpentine	5

Care must be exercised in application that no hard granules or flakes are present in the glue as these are likely to result in small pressure sloughs.

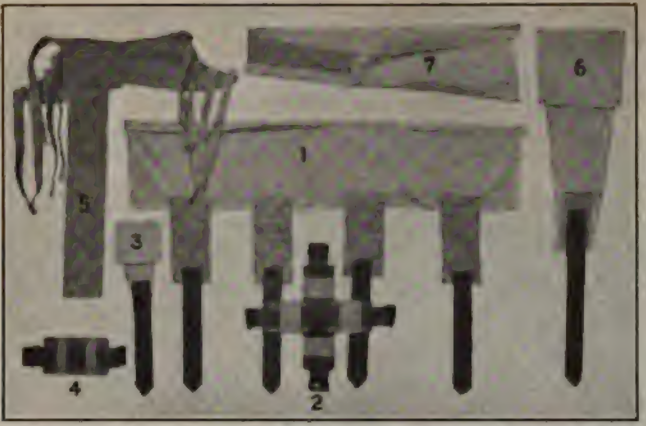

FIG. 1563.—Showing the pattern of the canton-flannel extension straps used for stump traction. (*Fauntleroy, Report on the Medico-Military aspects of the European War.*)

The material used was medium weight canton flannel. 1. The broad piece, with extension straps, used for the skin traction apparatus. 2. The wooden cross piece to which the above extension straps are buckled. 3. Cloth, with webbing extension, which is glued to the forearm in the overhead extension treatment of compound fractures of the humerus. 4. Wooden traction piece to which the foregoing webbing is buckled. 5. Cloth anklet used to obtain extension on the foot in cases where the wound in the leg was low down or involved the ankle joint. The horizontal piece is secured over the dressing around the ankle, while the vertical piece turns under the plantar surface and is afterward pinned to the horizontal piece. 6. Cloth extension strap, with attached webbing, to be glued to the leg in the application of the Blake splint. 7. A double extension cloth, the ends of which are glued to the leg, used as a substitute for adhesive plaster in the application of a Buck's extension.

FIG. 1564.—Showing an amputation stump of a case of progressive emphysematous necrosis (gas-bacillus infection) with the apparatus applied for pulling upon the skin. (*Fauntleroy, Report on the Medico-Military Aspects of the European War.*)

that the edges of the wound are soon approximated (Figs. 1563 to 1565). Reamputation is usually necessary later.

(*C*) Immobilization in infected wounds without fracture may be accomplished by any means which will efficiently prevent movement in the affected tissue planes. Bandages or even a sling and binder may be sufficient in the upper ex-

FIG. 1565.—Showing the completed dressing and apparatus for skin traction in position in the case shown in Fig. 1564. (*Fauntleroy, Report on the Medico-Military Aspects of the European War.*)

tremity. The padded woven-wire gutter splint with a lateral extension reaching the iliac crest is most generally serviceable in the lower extremity (Fig. 1566).

(*D*) The suppression of tissue infection remaining after the procedures described may be attempted in four ways:

(*a*) By the usual antiseptics.
(*b*) By embalming the infected tissue.
(*c*) By "lymph lavage."
(*d*) By the action of light and air.

(*a*) The usual antiseptics in war as in peace, have had a liberal trial as wound purifiers but, with a few notable exceptions, have not aroused great enthusiasm.

The best results have been reported from the hypochlorous acid solution (Eusol) of Lorrain Smith* and the sodium hypochlorite solution of

* Lorrain Smith's Solution.

Chlorinated lime (bleaching powder)	12½ g.
Water	1 L.
Shake well and add—	
Boric acid	12½ g.
Let stand over night and filter.	

Dakin* with the latter of which, Carrel believes he has been able to sterilize infected wounds.

For gas-infection Blake and Taylor have used in the American Ambulance of Paris, solutions of quinine hydrochloride† with most encouraging results.

All these solutions may be used as wet dressings, or instillations while the hypochlorite and hypochlorous acid may be used as an immersion bath and the quinine as a hypodermic injection.

(*b*) Embalming of the infected tissue has proved extremely efficient in the handling of gas- and other severe infections. For this purpose, the author has used Chlumsky's solution.‡ Wounds so treated separate sloughs quickly and extraordinarily cleanly and in gas-infections both gas- and suppurative organism appears to be subdued equally.

(*c*) "Lymph lavage" is particularly efficient in cellulitis. It may be induced by the use of the salt solution of Wright,§ the sugar solution of Whitehouse, or the magnesium solution of Morrison.|| It is probable that "lymph lavage" is an important element in the method used by Carrel. In this method an incision is made sufficiently large to permit

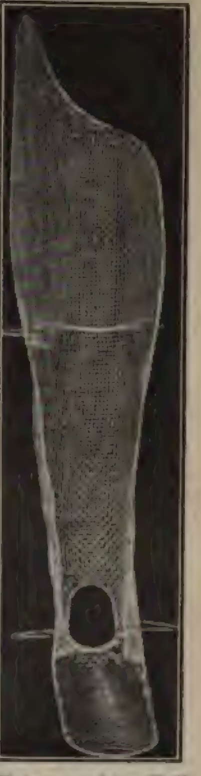

FIG. 1566.—Full length woven wire hip splint with lateral extension. These splints in the French army are supplied with special pads which fit them accurately.

* Dakin's Solution.

Dissolve dry sodium carbonate (Na_2CO_3)	140	g.
or crystalline sodium carbonate	400	g.
in tap water	10	L.
add chlorinated lime	200	g.
Shake well, allow to settle.		
Siphon off supernatant fluid and add—		
Boric acid	40	g.

Solution should not be used after one week old.

† Quinine hydrochloride is used as a wet dressing or hypodermic injection in a strength of 1 per cent. as an instillation in the strength of 1/10 per cent. combined with 1/10 per cent. hydrochloric acid or 1 per cent. alcohol.

‡ Chlumsky's solution is made as follows:

Melt, on a water bath, crystalline phenol	30
add gum camphor	60
followed by 95 per cent. alcohol	10 and filter.

This solution being of an oily consistency has the added advantage of preventing the adhesion of dressings to the wound.

Another solution prepared by Louis Menciere for a similar purpose has the composition:

Iodoform	10
Guaiacol	10
Eucalyptol	10
Balsam Peru	10
Ether	100

§ Wright's Solution.

Sodium chloride	4	or	5
Sodium citrate	1		1/2
Water	95		94 1/2

|| Morrison's Solution.

Magnesium sulphate	40
Glycerine	10
Boiling water	30

easy removal of foreign bodies. The wound toilet is accomplished without unnecessary traumatism and two tubes are inserted into the wound (or one in each wound if wounds of entrance and exit are present) and sealed air-tight by rubber dam glued to the skin. Dakin's sodium hypochlorite or one of the sulpho-chloramide solutions is allowed to enter one tube from an elevated reservoir at the rate of 1 or 2 liters a day while continuous suction is maintained through the other by means of a water jet. Discharges from the wound are arrested in a catch-bottle introduced into the suction line (Fig. 1567). By this method, Carrel appears to have attained as good results as others by the more heroic wide incisions.

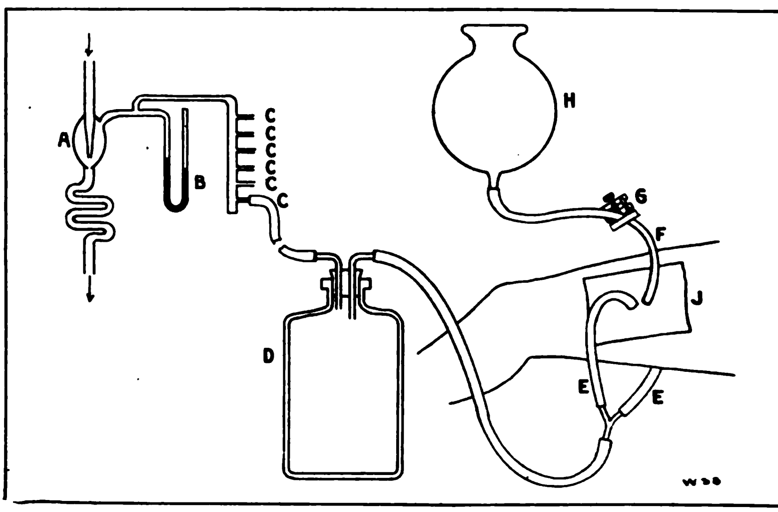

FIG. 1567.—Diagram of Carrel's apparatus for continuous irrigation with negative pressure drainage. (*Adapted from Fauntleroy, Report on the Medico-Military Aspects of the European War.*)

a. Water-jet for producing suction. *b.* Manometer. *c, c, c.* Connections for separate suction lines. *d.* Catch-bottle for arresting discharges from wound. *E, E.* Suction tubes entering wounds of entrance and exit. *F.* Tube carrying antiseptic to wound. *G.* Screw-cock for regulating flow of antiseptic. *H.* reservoir for antiseptic solution. *J.* Rubber dam.

(*d*) Light and air form most efficient adjuvants to any form of treatment in which their use is permitted.

If one were asked how theoretically to promote the multiplication of bacteria in a wound, he might answer, "Exclude light and supply heat and moisture" thereby accurately describing the conditions instituted by the usual sterile dressing. Exposure is carried out in fractional fashion, one hour twice a day at first, one and one-half hours twice a day on the second day, two hours twice a day on the third day and soon the wound is exposed all day or even day and night. Of direct sunlight smaller doses are given beginning with twenty minutes a day and increasing according to the strength of the rays and the tolerance of the wound. Too prolonged exposure to the sun, especially in the beginning seems sometimes to produce a sunburn of the tissues. It is advantageous to

combine shorter doses of sun exposure with the more extended open-air exposure. This treatment is also most efficacious in stimulating the growth of epithelium.

Finally, when the stage of clean granulations has been reached, wound closure may be greatly hastened and scarring minimized by approximating the wound edges with hot adhesive straps.

As emphasized by Bowlby, the surgeon must not forget that different types of infection as well as different stages in the same infection, require different treatment. The best and quickest results are often obtained by a well-chosen sequence as, for instance, "lymph lavage" until cellulitis is under control, then embalming or hypochlorite treatment and finally exposure with approximation by hot adhesive straps.

Excision and primary suture has been carried out by H. M. W. Gray with surprising success. Gray states the advantages of the method as follows:

1. "Healing by first intention is secured in the vast majority of properly selected cases.

2. Much time is thereby saved. Some wounds which would otherwise require months to heal, are actually united in the course of ten to fourteen days. The soldier is thus available for duty again at a much earlier date.

3. The amount of attention required to be given by the medical officers and nursing sisters, etc., is greatly reduced.

4. Much pain is avoided.

5. The amount of dressings required is reduced to a minimum, and in this way expense is lessened.

6. Complications which may arise from a septic wound are avoided.

7. A more sightly scar is obtained.

8. Because of the absence of contraction which would accompany the formation of a large cicatrix, there is less impairment of function in the part concerned.

9. In the cases of head injuries, excision of the wound, especially in some, apparently trivial, injuries provides a means of ascertaining with greater certainty than any other method, whether depressed fracture or injury to the brain coexists."

Contraindications are (1) marked induration about the wound which must be first removed by vigorous treatment with hypertonic wet dressings, (2) marked pocketing rendering it impossible to excise the infected tissue without opening some infected recess, and (3) the presence in an infected state, of nerves, vessels or bony prominences which may not be removed. Even in the latter groups of cases, however, it is advantageous to cleanly remove the devitalized and grossly infected edges of skin, fascia and superficial muscle.

The procedure is as follows:

(1) Shave and paint wound and surrounding skin with strong solution of iodine (5–10 per cent.) in spirit or ether.

(2) Wipe wound dry and pack with dry gauze.

(3) Infiltrate tissues about wound with a local anesthetic combined with adrenalin.

(4) Catch skin close to each end of wound with tissue forceps or sutures and have assistant make traction away from center of wound and at 45 degree angle with plane of skin.

(5) With very sharp knife cut out wound *en masse* keeping incision 1/8 to 1/2 inch from the raw surface and being careful to avoid cutting into pockets. Infected bony prominences may often be removed as part of the mass by dividing with a chisel or forceps after cutting the surrounding soft parts. If the wound is deep, one hand may be inserted in it.

(6) Wipe new wound surface with saline solution, pack with gauze and clean surrounding skin. From this point use fresh towels, instruments and gloves.

(7) Suture by deep sutures which under-run bottom of wound to obliterate dead space, or by layers. Approximate skin with a few fine sutures.

(8) Dress by painting suture line and adjacent skin with wound varnish (40 to 45 per cent. mastic in some volatile solvent) and after this has become sticky lay on at least two layers of gauze and smooth and pat it down, afterward applying and fastening the remainder of the dressing. For inspection later all gauze is removed except the single layer next the skin. This is not disturbed unnecessarily on account of its usefulness in relieving tension.

(*E*) Mobilization and massage should be begun as soon as all recesses of the wound are sealed by granulations and drainage is satisfactory. In the case of a stiff arm or hand, the patient may be encouraged in active movement by restraining the uninjured member.

Compound Fractures.—The two desiderata in the treatment of compound fractures are:

(1) To save the life of the patient and promote the final healing of the wound.

(2) To prevent deformity.

The first object is largely obtained by operation while the second depends upon immobilization. The superior work in these cases in the present European war, has emphasized the fact that good reduction is one of the greatest aids to good drainage, and that perfect immobilization minimizes the destruction of tissue and the spread of infection.

Operation.—Since most of these wounds contain foreign bodies (metal, clothing, etc.) the removal of these constitutes the first necessity. Free incision is made, usually longitudinally but sometimes transversely when swelling threatens otherwise to close the wound. In the thigh, transverse division of the fascia lata to relieve tension should be almost a routine procedure. The foreign bodies are found and removed, a large-ended probe being used freely but gently if desired. Fragments of bone, attached or not attached, are aligned with the major fragments as well as possible and left in place. Gross soiling of the fragments or interference with drainage is the only excuse for their removal. No metal should be introduced in spite of the recommendations of Lane plates published by men who have had limited opportunity to follow the course of their cases. In the cleaner cases, tenorrhaphies or neurorrhaphies may be done, and in any case exposed but undivided nerves or tendons may be saved

from later sloughing by barely covering them with a small flap of fat or muscle. If no closure is done, the wound is loosely packed with a Mikulicz tampon. Closure when done is accomplished by large interrupted sutures leaving liberal tube or other drainage.

Immobilization.—The chief aims of immobilization are:

(1) To maintain reduction.

(2) To minimize pain and discomfort.

(3) To facilitate drainage.

(4) To prevent spread of infection due to movements of muscles and bone fragments.

(5) To facilitate the treatment of the infected wound.

Different methods are therefore applicable in different cases.

FIG. 1568.—Wire "basket-handles" in place in preparation for making a yoked fractional cast. (*Tuffier, Surg. Gyn. and Obstet.*)

FIG. 1569.—Yoked fractional cast completed. (*Tuffier, Surg. Gyn. and Obstet.*)

Plaster-of-Paris Casts.—Moulded or circular plaster splints are, in general, inapplicable in war surgery except in relatively clean cases on account of the difficulties they oppose to the maintenance of cleanliness in and about the wound. The fenestrated cast soon becomes a foul and stinking thing. Yoked fractional casts as used and advocated by Tuffier are very comfortable, may be kept clean and, in some cases, answer the demands upon them admirably. The author has found, however, that especially in cases where one fragment is short, a sagging of that fragment is very likely to occur on account of the lack of both axial

traction and support from below. These casts are composed of a circular portion proximal to the wound and a second circular portion distal to it, the two being rigidly connected by three plaster "baskets handles" each with a tubular core of fine woven fencing wire. They are chiefly applicable in the thigh and

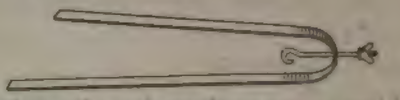

FIG. 1570.—Strap-iron yoke and traction screw as used by Wohlgemuth. (*Deutsche Med. Woch.*)

leg but modifications may be used with advantage in some fractures about the elbow (Figs. 1568 to 1569).

Plaster Sleeves with Screw Traction.—Wohlgemuth has recently advocated the association with a plaster countertraction sleeve of a long U-shaped bow of iron through the convexity of which passes a long screw bearing a thumb-nut.

FIG. 1571.—Wohlgemuth's traction splint as applied to wounds about the elbow. (*Deutsche Med. Woch.*)

By means of this screw, traction is exerted on the lower fragment. It is used on either extremity (Figs. 1570 to 1572).

Modified Thomas Knee Splint.—Robt. Jones, Jos. A. Blake, Cuthbert Wallace, C. Max Page, and others have independently modified the Thomas knee splint for use in compound fractures of the femur, the two former having also

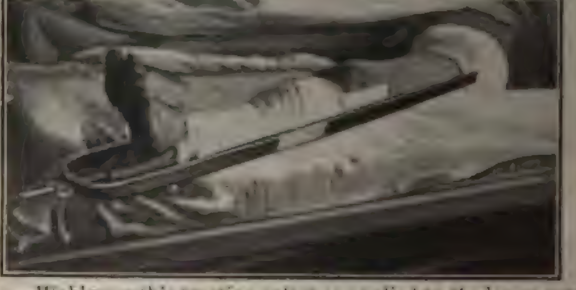

FIG. 1572.—Wohlgemuth's traction splint as applied to the lower extremity. (*Deutsche Med. Woch.*)

devised adaptations for use in fracture of the humerus. The mechanism of these is made sufficiently clear in the illustrations shown (Figs. 1573 to 1577). The limb is supported at its ends by the traction and countertraction members and between these points by a hammock of stout bandage passing

FIG. 1573.—Thomas's knee splint, with strapping extensions, local splints, wadding and bandages used in application. (*Robert Jones, British Med. Journ.*)

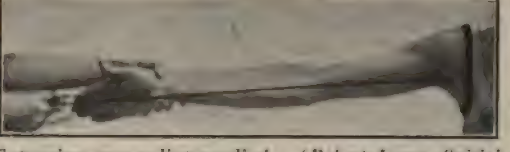

FIG. 1574.—Extension arm splint applied. (*Robert Jones, British Med. Journ.*)

FIG. 1575.—Showing Blake's splint applied to a compound fracture of the middle third of the femur with openings above and below for drainage. (*Fauntleroy, Report on the Medico-Military Aspects of the European War.*)

FIG. 1576.—An improved model of Dr. Blake's splint for the right femur. (*Fauntleroy, Report on the Medico-Military Aspects of the European War.*)

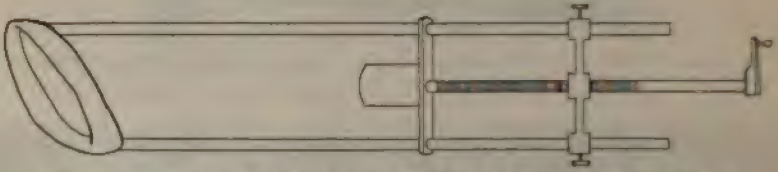

FIG. 1577.—Cuthbert Wallace's modification of the Thomas knee-splint.

FIG. 1578.—Modified Thomas's humerus extension splint. (*Robert Jones, British Med. Journ.*)

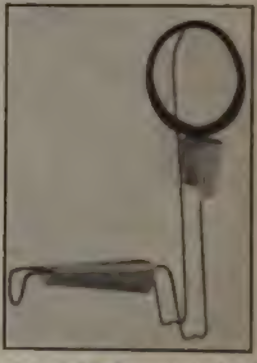

FIG. 1579.—With supporting bands in position. (*Robert Jones, British Med. Journ.*)

FIG. 1580.—Modified Thomas's humerus extension splint applied. (*Robert Jones, British Med. Journ.*)

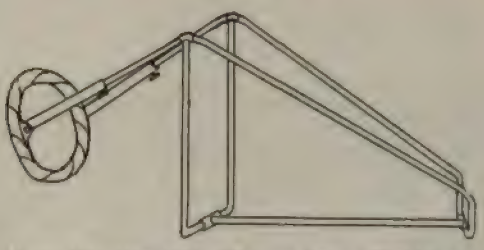

FIG. 1581.—Hey Grove's modification of the Thomas knee splint for securing a flexed position of the knee.

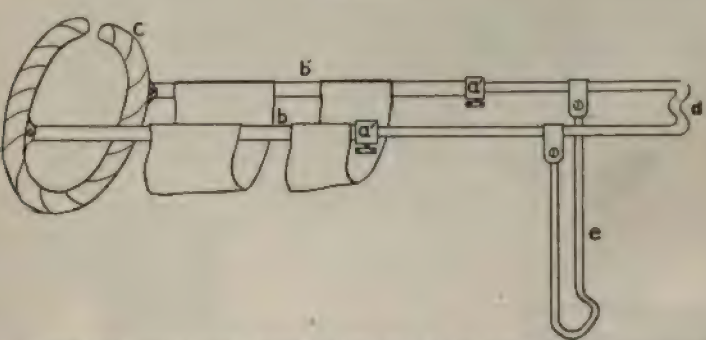

FIG. 1582.—Hayes's adjustable and standardized splint for treatment of fractures of leg and thigh.

The ischial ring *c* is so hinged to the hollow tubes *b* and *b'* that the splint may be adapted to use on either right or left side, the amount and direction of the inclination being determined by the position of the clamps *a* and *a'* on the bow, *d*, which telescopes into the tubes *b* and *b'*. *e* is a hinged bracket for elevating the distal end of the splint.

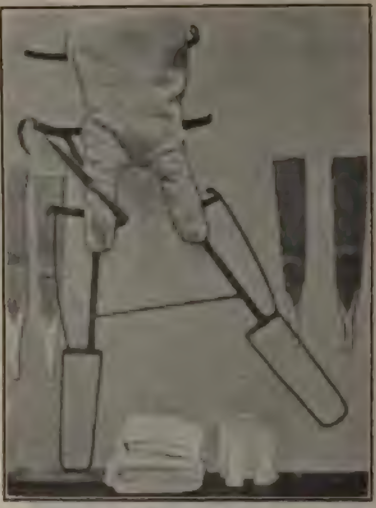

FIG. 1583.—Left abduction frames with strapping extensions, wadding and bandages used in application. (*Robert Jones, British Med. Journ.*)

FIG. 1584.—Compound fracture of middle third of humerus treated by suspension with longitudinal traction. (*Fauntleroy, Report on the Medico-Military Aspects of the European War.*)

between the side members of the frame. In transportation and during dressings, traction is made by fastening the traction straps or cords to the distal end of the frame; at other times, by weight and pulley as in the well-known Buck's extension. This relieves the points of countertraction and prevents discomfort. The flexed position of the knee and elbow necessary in certain

FIG. 1585.—One of the wards in Dr. Blake's service showing trestle work over the beds for applying overhead extension or suspension. (*Fauntleroy, Report on the Medico-Military Aspects of the European War.*

FIG. 1586.—Steinmann's pin introduced through condyles of femur for fracture of the shaft. Ligaments of knee-joint are not stretched and movement at knee is not prevented.

cases is provided for by modifications of these splints as shown above (Figs. 1578 and 1581).

The most recent addition to this group of splints, suggested by W. B. Hayes, is adjustable for either leg and for any length of leg and is provided with a hinged bracket for elevating its distal end (Fig. 1582). It should prove especially useful as a stock brace in base hospitals where the tendency to loosening of the adjustments, inevitable in transport, would not prove a disadvantage.

The Jones Abduction Frame.—For fractures of the hip and upper thigh th Jones abduction frame gives a maximum of fixation and comfort both i transportation and in the hospital (Fig. 1583).

The combination of vertical suspension with corrective traction by weight and pulleys, as so perfectly worked out by Blake in the American Ambulance i

FIG. 1587.—Steinmann's pin inserted through crest of tibia just below tuberosities; for compound fracture just above knee-joint.

Paris, is especially useful in securing correct alignment of fragments in fractures about the elbow. (Figs. 1584 and 1585).

Steinmann's pins, (Figs. 1586 and 1587) though *apparently* not perfectly safe in the neighborhood of infected wounds, have given the author the highest satisfaction, having been used as near as 3 inches to highly infected wounds

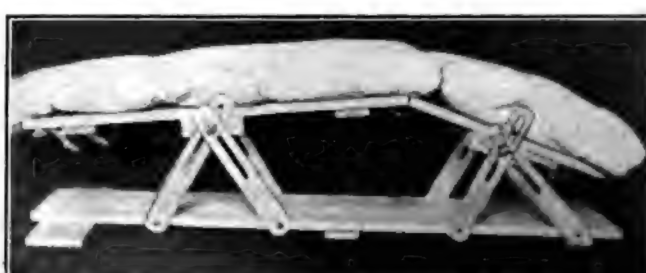

FIG. 1588.—Lyle's adaptation of the St. Luke's Hospital Splint for use with Steinmann's pi

without resultant infection about the pin. Insertion is done under local anæs- thesia and is practically painless. In the after course there is no pain (from th traction device) no unnecessary stretching of ligaments, a maximum reductio with moderate traction, ability to modify the position of joints below the pi and hence the ability to assume the most advantageous position, and usu

absolute accessibility of the wound. In leg cases, in which the method is chiefly applicable, the efficiency of the treatment is doubled by the use of the St. Luke's Hospital splint (Fig. 1588) which was introduced into military surgery by Lyle of New York. This splint consists essentially of a supporting platform bearing a double inclined plane capable of any angular adjustment. The bed of the splint is covered by a jointed mattress, its two divisions being fastened respectively to the two members of the double inclined plane and its distal portion being split to give place to the prominence of the heel.

The method of inserting Steinmann's pin is as follows:

(1) Shave the skin and sterilize with Tr. Iodine.
(2) Select site for perforation of the bone (preferably in cancellous bone avoiding epiphyseal lines and diverticula of joints).
(3) Draw skin upward to find relation of surface to chosen bony point after traction is established.
(4) Anæsthetize site of entry and site of emergence of pin, both superficially and deeply.
(5) Incise chosen points in skin down to bone and in a direction parallel with the axis of traction (3/8–1/2 inch is sufficient).
(6) Engage pin in an unsterilized machinist's hand drill and leave remainder of sterile work to assistants.
(7) While assistant draws skin upward on *both* sides, enter pin through middle of skin incision and drive through bone horizontally in a direction perpendicular to the future traction axis.
(8) If the pin does not appear in the short incision on the opposite side, make new incision in the proper place as soon as this is apparent.
(9) Dress by impaling a small plain or iodoform gauze sponge on the point of the pin while a second unravelled sponge is wrapped about the pin over the opposite wound, both being held in place by a loose bandage looped back and forth around the ends.

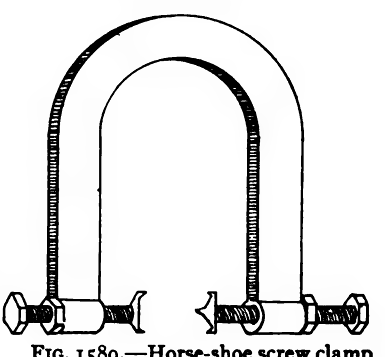

FIG. 1589.—Horse-shoe screw clamp of Hey Groves for applying traction in T- and Y-fractures in the neighborhood of joints.

The yoke used for applying traction is self-retaining when in use. Weight is employed as in any traction system. Inward or outward rotation of the lower fragment may be controlled by a small weight acting over a pulley and attached to the inner or outer limb of the traction yoke.

After three weeks traction may usually be abated and the pin cleaned and removed by withdrawing it away from the point. More than four weeks' traction may result in sequestration of bone along the course of the pin.

Double-pin traction is useful in many cases and has the additional advan-

tage of permitting the patient freedom from his bed. A useful form devised by E. W. Hey Groves is shown on page 905 (Fig. 1024).

The horse-shoe screw clamp also introduced by Hey Groves is useful in comminuted fractures of the lower ends of bones since it permits the application of coapting pressure upon fragments separated by more or less longitudinal fissures together with traction on the lower fragment group as a whole (Fig. 1589).

JOINT INFECTIONS

Not all military wounds of joints result in suppuration. Clean rifle or machine gun bullet wounds usually escape gross infection. The author has even seen a case in which a single bullet traversed both knees without resulting suppuration. Such cases require only prophylactic treatment, *e.g.*, sufficient immobilization with aspiration if necessary, and later passive movement and massage.

For the sake of brevity, the most important and troublesome articulation, the knee-joint, will be discussed. Categorical rules cannot at this time be laid down since no other class of cases seen in war present greater surprises in the course of treatment. Certain general principles, however, may be decisively pronounced.

(1) Immediate and efficient immobilization preferably combined with traction to prevent the dissemination of infectious material within the joint and to relieve pain.

(2) Removal of any intra-articular foreign body at once, whether clearly causing trouble or not. (This need not include bodies finding entrance to bone by extra-articular routes.) Especially should fragments of clothing be searched for in connection with shrapnel balls, shell fragments or deformed bullets.

(3) Clean excision of devitalized tissue along the track of the projectile. This saves the time necessary for the separation of sloughs and improves drainage.

(4) Free tube or other efficient drainage *down to but not through* the synovia. As Gray aptly says, "Since it is so important to remove foreign bodies from the interior of the joint, it seemed a futile proceeding to introduce others, especially when these establish free communication with septic surfaces either of the wound or of the skin, as tubes do." Certain intensely septic cases require drainage through the synovia. In these almost or quite uniformly a long septic course finally results in the separation of the cartilages and their surgical removal and the optimum result is ankylosis.

In some cases division of the patella and the entire anterior portion of the capsule with open exposure of the synovial surfaces by bandaging the leg to the thigh after the method of Peck, is required to produce sufficient drainage. These cases, of course, must be subsequently resected.

In certain cases of early or slowly progressive infection with small wounds which do not allow free drainage and without retained foreign bodies, the author has had most gratifying results from repeated aspiration, having seen on a

number of occasions, the joint fluid became less turbid with each aspiration until finally clear. In these cases, five to ten drops of Chlumsky's camphor-phenol solution were injected after each aspiration, but whether or not it was a factor in the good result, has not been determined. Others have reported the use of injections of formalin-glycerine, iodoform-ether and pure ether, certainly without damaging and perhaps, with beneficent results. If these procedures fail, recourse must be had to the more radical measures already mentioned.

In all drainage cases, good results are reported from the use of hypertonic saline dressings though in some cases, continuation of this treatment seems to result in more or less severe hemorrhage.

LOCALIZATION OF FOREIGN BODIES

Aside from the visual recognition of incompletely covered foreign bodies. there are three general methods of localization.

(1) By palpation, directly or by means of instruments.

(2) By magnets.

(3) By the use of the Roentgen ray.

1. **Palpation.**—Of manual palpation, nothing need be said. Palpation by means of probes falls into two classes. That by means of a simple probe, and that in which the telephone probe is employed.

In spite of the dictum of von Bergmann, it is undeniable that the naked probe has a useful function in the localization of foreign bodies in war. Fine-pointed probes undoubtedly have a tendency to open new planes to infection, but large probes, with bulbous extremities not less than 1/8 inch in diameter, have proved harmless and efficient in locating foreign bodies at the bottom of well-defined penetrating wounds. If the probe is held so lightly between thumb and index-finger that it may be gently rolled back and forth as its point is advanced, it will not make false passages and will frequently permit the expeditious localization of suspected foreign bodies.

The Telephone Probe.—To obviate the difficulty not infrequently experienced in recognizing the contact of probe and foreign body, MacKenzie Davidson has urged the employment of the telephone probe and has devised means of using the telephone attachment on any instrument employed in this operation. The action of this instrument depends on the fact that small electric currents are generated by contact of dissimilar metals. The apparatus consists of one or two small telephone receivers adjusted to the ear or ears of the operator, one pole of the circuit being connected with a moistened carbon plate on the patient's skin and the other with a probe or other instrument.* One or two dry cells introduced into the circuit increase the effectiveness of the apparatus. When the instrument employed for palpation touches a foreign body, a distinct click is heard in the receivers. Care need only be taken that the click heard

*Mr. Gillies has shown that the moveable end of the circuit may be applied through the medium of a copper plate to the arm of the operator instead of directly to probe. In this case, of course, rubber gloves cannot be used.

is not elicited by accidental contact of the probe with a retractor or othe instrument. To prevent confusion from this source, probes for the purpose ar sometimes covered with vulcanite or some other non-conductor except at thei tip, a device which also removes uncertainty as to what portion of the prob has touched the foreign body.

Magnets.—Localization of magnetic projectiles by means of simple electro magnets is of limited usefulness in war on account of the depth of the foreig bodies and the limited range of the magnets, but Prof. Bergonie of Bordeau by introducing a motor-driven current-reversing device in the circuit, ha greatly extended the scope of this means of localization. As the pole of th magnet is passed over the surface of the body, a finger being interposed, near ness of a magnetic foreign body is revealed by a purring sensation transmitte through the skin. The pole-extension of the magnet may be sterilized and a the incision is carried down, the purring becomes stronger until on near ap proach, a visible vibration of tissue reveals the site of the foreign body t the eye.

Localization by use of Roentgen rays may be radioscopic or radiographic For obvious reasons, the former is preferable in cases where the latter doe not present special advantages.

Radioscopic Methods.—In some cases sufficient information may be ob tained by very rapid and simple methods.

Palpation Under the Screen.—Superficial foreign bodies not recognizabl by simple palpation, may be located by palpating or percussing the overlying tissues under the fluoroscopic screen. The point on the surface at which pressure or percussion produces the greatest excursion of the shadow of th foreign body, is obviously most directly above the latter. This point is marked with silver nitrate and the patient placed on the operating table in the attitud in which the observation was made. Incision carried down normal, *i.e.*, per pendicular, to the surface at this point will usually reach the foreign body When possible, as in most extremity cases, the body should be so placed tha the axial ray traverses a plane parallel to the tangential plane of the surfac at the point nearest the foreign body, *i.e.*, if the foreign body is in the latera portion of the thigh, the patient should lie on back or face. In this relatio excursions of the shadow are most readily detected.

Ascertaining Relative Depth by Movement of X-ray Tube.—It is wel known that the farther an opaque body is from the screen, the greater will be it excursion where the tube is moved in a plane parallel to that of the screen Thus, if it is desirable to find whether a foreign body lies above or below th bone, a greater excursion of the foreign-body shadow than that of the bone whe the tube is moved as described, indicates a deeper position of the foreign body Conversely, if the excursion of the foreign-body shadow is less than that of th bone shadow, the foreign body must be superficial to the bone. If both ar equal, the foreign body lies in the plane of the bone.

Radioscopic Localization in One Plane.—Radioscopic Triangulation. This method was first advanced by MacKenzie Davidson. In its simplest form, it is

carried out as follows. With the tube underneath the table and a fluoroscopic screen firmly supported above the patient in a horizontal position and at a known distance from the tube, find the shadow of the foreign body. Close the diaphragm (which must be centered with the target of the tube) to the smallest aperture that will show the shadow of the foreign body. Mark on the screen the position of some definite point on the contour of the latter. For the sake of accuracy, this marking is best done by means of sharp-pointed metal indicators which may be fastened to the frame of the screen.

Move the tube in the horizontal plane a known distance and mark the new position of the chosen point of the shadow contour. Make a chart as shown below (Fig. 1590) indicating graphically the two positions of the anti-cathode,

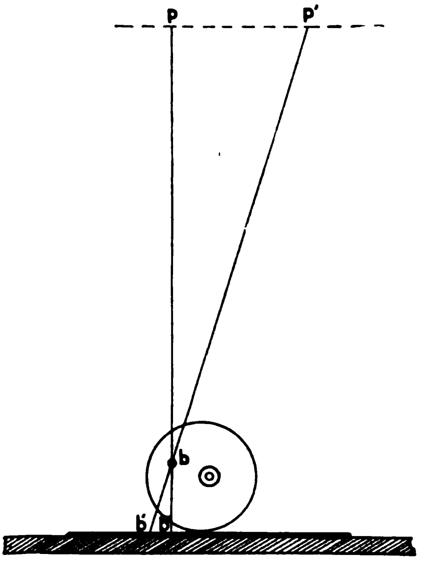

FIG. 1590.—Determination of the depth of a foreign body by radioscopic triangulation.

Pb'' is the distance from level of tube to level of screen (or plate, if radiographic method is used). *P* represents first position of anticathode and *b''* represents first foreign-body shadow. *P'* represents second position of anticathode and *b'* the foreign-body shadow produced in this position. If then the lines *Pb''* and *P'b'* are drawn, their intersection at the point *b* must indicate the locus of the foreign body. The length of the line *bb''* therefore indicates the actual distance of the foreign body from the screen or plate.

the plane of the screen and the two positions of the shadow—all in their actual measurements.

Indicate by two straight lines the axial ray from each position of the anti-cathode to the corresponding shadow. The intersection of these two lines marks the site of the selected point on the foreign body. The actual distance from the screen to this point is then determined by actual measurement on the chart.

The result may be obtained arithmetically according to H. R. Bramwell as follows:

Multiply distance from anti-cathode to screen by amount of excursion of

shadow on screen and divide product by sum of amount of displacement of tube and amount of excursion of shadow. Thus, if

A = distance of screen from anti-cathode
S = excursion of shadow, and
T = displacement of tube

the formula $\frac{A \times S}{T + S}$ = the distance of foreign body from screen.

Localization by a Director.—W. Ironside Bruce has devised a combined operating and fluoroscopic table in connection with which he uses a director as follows:

The tube with centered diaphragm being movably suspended beneath the table, a fluoroscopic screen is held over the patient by means of an arm which can be moved aside and accurately returned to its original position. The foreign body is found on the screen, the diaphragm closed down to the smallest

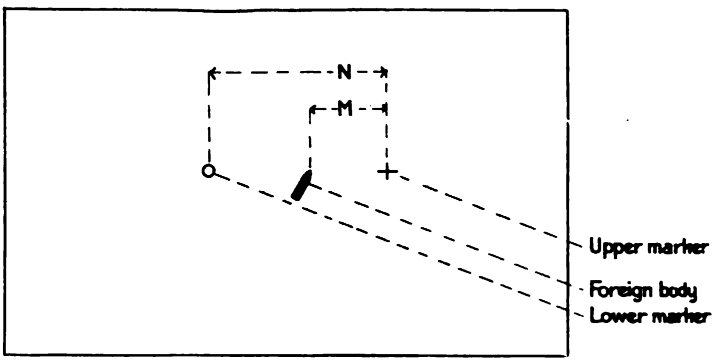

FIG. 1591.—Lindsay's method of estimating depth of foreign body.

workable diameter, and the fluoroscopic screen adjusted until the shadow thrown by the axial rays is in its center. The room is then lighted and the fluoroscopic screen replaced by a guiding tube so constructed that its center will exactly occupy the former position of the center of the screen. Since the guide tube is so devised as always to occupy a vertical position, a directing pointer passed through it must inevitably touch the foreign body if the latter remains unmoved.

At the point on the surface indicated by the director, a skin incision is made and the director (sharp or blunt as circumstances may dictate) is passed into the tissues until the foreign body is touched. The director may be combined with a telephone probe to facilitate the recognition of the foreign body when touched.

Localization by Director.—Method of W. S. Lindsay. As in the method just described, locate foreign body by axial rays. On the upper and lower surfaces of the part, place some small opaque body so that the shadows of the two may coincide with some definite point of the foreign-body shadow, e.g., the point of a bullet. The tube is then moved 3 inches in a horizontal plane

and the new positions of the three shadows indicated on screen or by exposing a plate in the plane of the screen (Fig. 1591). The depth of the foreign body is then estimated by the following formula:

Let b = distance from anode to surface of screen
n = distance on screen or plate between the two marker shadows
m = distance on screen or plate between foreign-body shadow and anterior or upper marker shadows
a = displacement of tube.

The foreign body must lie between the two surface points marked at a distance from the anterior or upper mark equal to $\frac{bm(a + n)}{a(a + m)}$.

Now take Lindsay's localizing caliper shown below, Fig. 1592, and adjust point "E" to touch anterior mark while point "C" touches posterior mark on surface of limb. Then remove and adjust tip "K" of indicator at the point between "E" and "C" at which, as shown by the formula, the foreign body must lie.

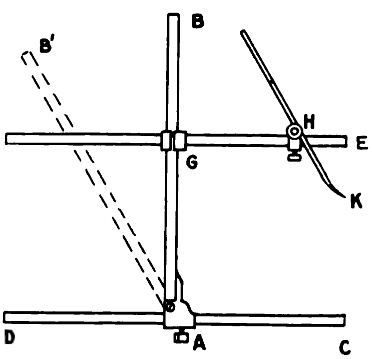

FIG. 1592.—Lindsay's localizing caliper.

Incise through anterior marked point. When the incision is sufficiently deep so that the arm "AB" is able to stand erect while the point "C" touches the posterior surface mark, the tip "K" of the pointer should touch the foreign body.

Author's Method.—This method was suggested by that of Wullyamoz for removing foreign bodies from the brain. In addition to the tube and screen, a small special instrument is required which, however, is of small cost and may even be improvised. The construction is sufficiently clearly shown in Fig. 1593.

The procedure is as follows:

Having located the shadow of the foreign body by means of the axial ray upon a large screen firmly supported about 6 inches above the surface of the part examined, the surface is painted with iodine, cocainized and a small skin incision made in the center of the shadow. The special canula bearing the blunt or sharp trocar as circumstances may indicate, and held by a strong clamp at right angles, is then entered through the skin incision. The room is then

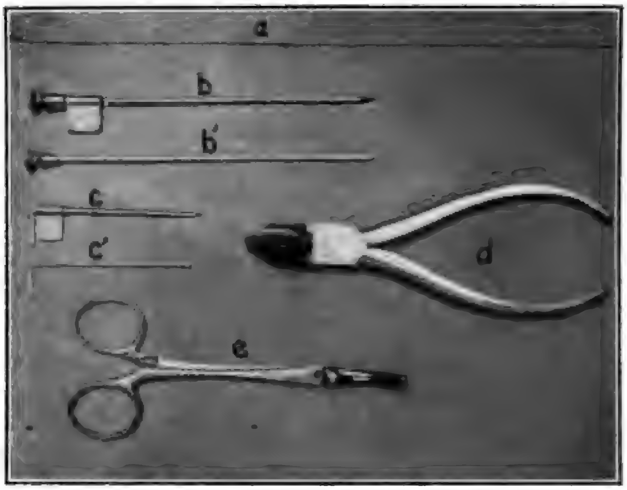

FIG. 1593.—Author's localizing device.

c indicates latest form of canula with sharp trocar. *c'* is blunt trocar for use with same canula. *e* is a curved hemostat for grasping the trocar, *c*. *a* represents the hooked piano wire which is introduced through the canula and left as an indicator. *d* indicates wire cutters employed to snip off the excess piano wire after introduction. *b*, *b'* indicate the original form of the instrument; the large head interferes with "sighting."

FIG. 1594.—Showing method of introducing author's localizing canula. (Plate used by courtesy of the *Annals of Surgery.*)

darkened and under the guidence of the X-ray the instrument is driven through the tissues. (Fig. 1594). As long as the point is advancing straight toward the anode (and hence toward the foreign body) the shadow of the point will be hidden by the shadow of the upper portion of the instrument.

When the trocar strikes the foreign body, the patient invariably complains of a sharp pain. Contact is then verified by slight waving movements of the point of the trocar which can be made to cause the foreign-body shadow to describe a circular excursion on the screen.

The current is now cut off, the screen removed and the room lighted while the operator continues to hold the trocar immovable. Next the trocar is withdrawn from the canula and one of the small hooked piano-wire indicators inserted in its place. Holding the hook of the latter against the foreign body, the canula is withdrawn and the wire snipped off ¼ inch above the skin. Over this a fairly thick dressing is applied.

If other foreign bodies are present, each may be localized in the same way. On the operating table each indicator may be readily followed to the corresponding foreign body.

The particular advantages of this method are:

(1) Operations may almost always be done under local anesthesia.

(2) Changes in the position of limbs or body do not vitiate the result.

(3) There are no calculations to introduce a possible mathematical error.

(4) The localization may be carried out aseptically without sterilizing the hands.

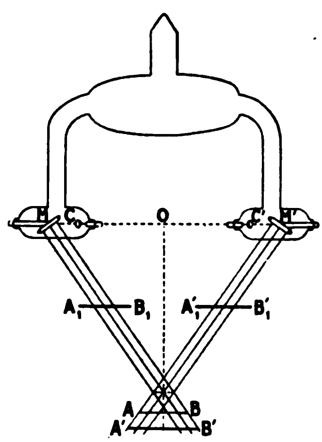

FIG. 1595.—Bi-tubular tube of Foveau. (*Arch. of Radiol, and Electrotherapy.*)

Radiographic Methods.

Stereoscopic plates are particularly useful in cranial and thoracic cases but are unfortunately, rarely applicable under war conditions.

Radiographic triangulation is done exactly as described for radioscopic triangulation with the exception that a plate is used instead of the screen, two exposures being made on the same plate. This method is more accurate than

the radioscopic one on account of the greater nicety of measurements on the plate as compared with the screen.

The ease and accuracy of this method are increased by using the twin tube of Dr. Foveau (Fig. 1595), which makes the two exposures simultaneously.

Shaxby's Method.—Shaxby uses a sort of ladder as shown below (Fig. 1596), with oblique fuse-wire "rungs." This is placed vertically upon the plate beside the limb or part to be radiographed in such relation to the tube that the shadows made by two exposures will be thrown in opposite directions. Two exposures are then made on the same plate from different tube positions (of course, in the same horizontal plane). The result is two foreign-body shadows and two converging sets of fuse-wire shadows. (Fig. 1597).

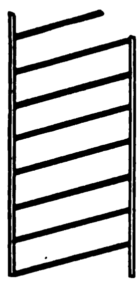

FIG. 1596.—Shaxby's fuse-wire ladder.

The angle between the two sets of wire shadows is bisected by a construction line. The distance between homologous points on the two foreign-body shadows is then taken with dividers and applied to the wire shadows in such a way that the divider points coincide with homologous points on the two shadows of a single wire. These homologous points will always lie in a line perpendicular to the construction line. The points thus found on the plate indicate a definite point on one of the rungs which must be at the same depth as the foreign body. Measurement from the plate to this point on the ladder will then yield the distance of the foreign body from the plate.

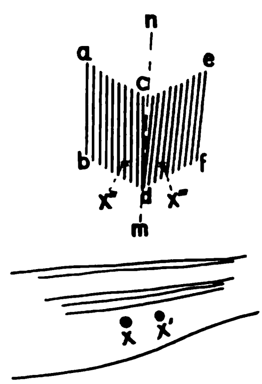

FIG. 1597.—Showing method of determining depth of foreign body by use of Shaxby's fuse-wire ladder.

ABDOMINAL WOUNDS

Abdominal wounds in war should be treated exactly like similar cases in civil life. This implies early exploration and repair of damage to viscera. Progress in this branch of military surgery depends on the shortening of the time between injury and operation. The mobile surgical ambulances recently introduced by the French, each consisting of a perfectly equipped surgical plant for 100 cases capable of transportation at 15 miles per hour in ten motor trucks, should improve the results in such cases.

While awaiting operation or transport, these cases should have full doses of morphine and should be placed in a sitting or, at most, a semi-reclining position. Where practicable saline should be administered by rectum. During, transportation the sitting position should be maintained.

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